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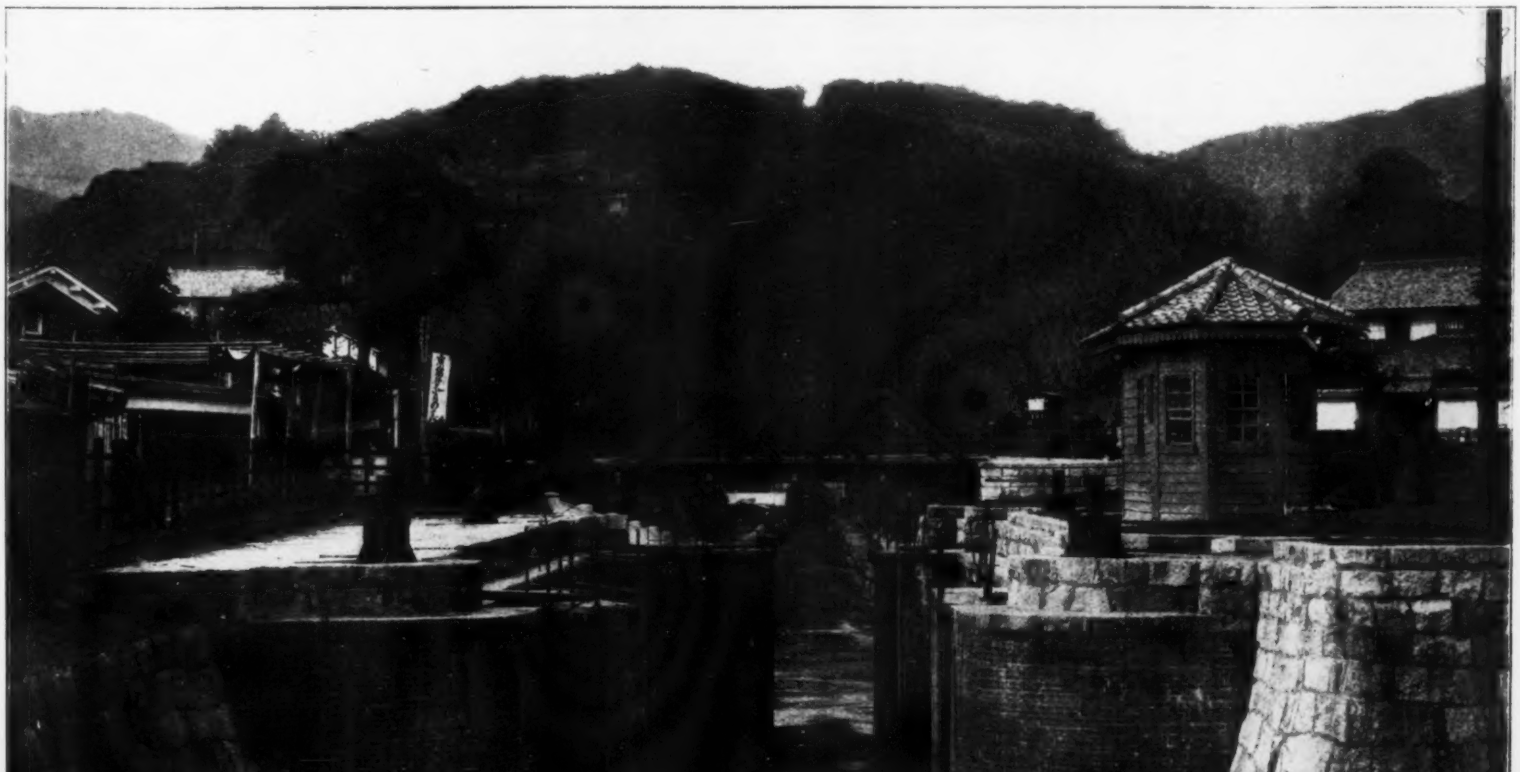
THE JAPANESE INCLINED PLANE, ELECTRIC CABLE RAILWAY OF THE LAKE BIWA CANAL.



LOCK AT THE INTAKE OF THE LAKE BIWA CANAL, LOOKING TOWARD TUNNEL No. 1.

ELECTRIC POWER IN JAPAN.

THE JAPANESE HYDRO-ELECTRIC POWER PLANT AT KYOTO AND LAKE BIWA CANAL DEVELOPMENT.*

By Frank C. Perkins.

Japan is without question the most progressive country in the Far East. Out of a total of more than a hundred electric power plants already installed and in operation in Japan, at least one-half of these are hydro-electric stations thoroughly up to date in every way. The available water-power in the empire reaches millions of horse-power, and the Japanese are rapidly taking advantage of the same by installing electric power-transmission plants in various localities.

The Lake Biwa canal, which not only supplies water-power to the present hydro-electric station at Kyoto, but also affords a continuous line for boat navigation from Lake Biwa to tidewater in the bay of Osaka, may be instanced. This canal not only yields power for the Kyoto municipal electric works, but a portion of its water is employed for the purpose of irrigating extensive fields of rice in the agricultural district adjacent to it.

Plans and surveys have already been made for a proposed new waterway, and the power plant and new canal of much larger capacity than the present one is under development. The waterway is to be constructed parallel to the existing canal, so as not to interfere with the working of the present system. The intake will be located at the north of the present canal, and an independent regulating sluice will be constructed, the present canal being protected with reclaimed land.

The new waterway will not be used for navigation, and a much greater volume of water will be carried than can be admitted into the present canal, as the depth of water will be increased, although the cross section will be reduced. About three-fourths of the distance from the intake to the site of the proposed new power station, a distance of about five miles, a tunnel will be constructed having a capacity of 550 cubic feet per second, the fall being 1 in 2,615. Where the new waterway joins the present Lake Biwa canal, at the north of the fourth tunnel, the width as well as the depth will be increased, and for the use of a new power station a new intake will be provided.

There are to be four turbines of 1,100 horse-power each directly coupled to electrical generators. One pipe of four feet diameter is to be installed for overflow, and four pipe lines of the same size will be provided for the turbines, the total length being 1,650 feet. For the future water supply of the city of Kyoto 50 cubic feet per second will be reserved from the total capacity of 550 cubic feet of water per second of the canal the remaining 500 cubic feet of water per second being utilized for the electrical power development.

The accompanying illustrations and drawings show the present hydro-electric power development at the Lake Biwa canal. The length of the main canal is 7 miles from Lake Biwa to the city of Kyoto, and from the city of Kyoto to Fushimi is 5½ miles, while the length of the branch canal is 5¼ miles, including nearly two miles of tunnel. The capacity of the main canal as at present operated is 300 cubic feet per second. The proposer of the canal scheme was Baron K. Kitagaki, and the consulting engineer S. Tanabe, M.E., while the chief electrical engineer is G. E. Kato.

The power station is 138 feet long and 115 feet wide, and has a total capacity of 1,785 kilowatts. There are five lines of pipe 3 feet in diameter supplying the turbines of the power station with 250 cubic feet of water per second under an effective head of 100 feet. There are nineteen dynamos installed, supplying current to power-transmission lines having a total length of 218 miles. Lake Biwa, 280 feet above the sea level, is the largest lake in Japan, covering an area of 400 square miles. There is a large section of reclaimed land extending nearly a quarter of a mile from the shore at the left of the canal entrance. This land is being reclaimed by using the materials from the tunnel and canal excavations.

An electrical pumping station has been installed here for supplying water to the city of Otsu on Lake Biwa, the electric motors driving the pumps being supplied with current from the power-transmission line. The main canal, which connects with the river Kamo at the city of Kyoto, includes two locks, three tunnels, and an inclined plane.

There is a difference in level between the outlet and intake of 140 feet, nearly all of which is overcome by a lock and the inclined plane, the canal gradient having a fall of 11 feet or 1 in 2,000. The total length of the incline, which is said to be the longest in the world, is 1,820 feet, and it connects canals that have a difference in level of 118 feet, the plane having a slope of 1 in 15. This incline is electrically operated by a 50 horse-power Sprague motor, supplied with current at a pressure of 500 volts.

The electric motor drives a drum which is 12 feet in diameter, around which is wound several times a four-inch steel wire cable 5,000 feet in length, the cable passing over threescore grooved pulleys located at various points from the lower pool or tail-race to the high-level canal. A railway has been constructed with 75-pound rails on wooden ties, with a gage of 8 feet 3 inches. Two cradles with eight wheels are attached to the wire rope, and upon these cradles a boat of 5 or 10 tons can be carried up or down in less than one-fourth of an hour either empty or loaded.

The power house is of brick construction, provided with granite steps on the north side leading to the two main entrances. There are in the power house twenty Pelton waterwheels operating under a head of 100 feet.

These turbines are supplied with 250 cubic feet of water per second through five iron pipes 6,300 feet in length and 36 inches in diameter. The water, after passing through the turbines, enters a discharge tunnel 10 feet high and 12 feet wide. A most interesting feature of this installation, showing the desire of the Japanese to be thoroughly up to date and become well acquainted with the best modern practice, is the remarkable variety of electrical generators installed in this power station from the time it was constructed up to the present time. The installation includes four direct-current machines, of 100-kilowatt capacity, constructed by the General Electric Company, and one of the Westinghouse type of the same capacity, all of which operate at a pressure of 500 volts. The current is used for electric railway and power purposes, and for silk spinning and ice making. There are also two Edison 80-kilowatt machines of the direct-current type among the first installed, operating at a speed of 600 r. p. m. and a pressure of 500 volts, the current being used for power purposes.

Among the alternating-current machines in the power plant are single-phase, two-phase, and three-phase machines with various frequencies and pressures. For lighting two Thomson single-phase alternators of 60-kilowatt and 75-kilowatt capacity were installed, having a frequency of 125 cycles per second, the former having a pressure of 2,000 volts and the latter 1,000 volts, the speed being 1,500 and 1,070 r. p. m. respectively. The two-phase alternating-current dynamos include three 80-kilowatt Stanley machines having a frequency of 133 cycles and a pressure of 2,000 volts, these machines operating at a speed of 1,000 r. p. m.

There is also a remarkable variety of three-phase generators in use in the station, including three General Electric machines of 80, 150 and 250-kilowatt capacity, operating at 900, 600, and 450 r. p. m. with a pressure of 2,000 volts and a frequency of 60 cycles per second. There are also four three-phase alternators having a frequency of 50 periods per second and 2,000 volts pressure, constructed by Siemens & Halske. These machines each have a capacity of 80 kilowatts and operate at a speed of 500 r. p. m., the current being utilized for lighting and power purposes, the motors being installed in cigarette factories, weaving, cotton spinning, and other mills.

The motors employed on the various lines are as remarkable in variety and size as are the generators. They operate at pressures of 120, 200, 500 and 2,000 volts from direct-current circuits, two-phase and three-phase circuits, and range from ½ horse-power up to 150 horse-power capacity. There are motors of 200 horse-power transmitting power for electric tramway, and two General Electric synchronous motors of 100 and 200 horse-power capacity operating directly at a pressure of 2,000 volts from a three-phase power circuit, as well as eighteen motors of the same type having an output of 684 horse-power.

The induction motors operate on two-phase and three-phase circuits at 120 volts, 200 volts, and 2,000 volts, ranging in size up to 100 horse-power, these machines being of the Westinghouse, General Electric, Stanley, and Siemens & Halske types. The direct-current motors all are operated on 500-volt circuits and are not of large capacity, the fifty-five Edison, Crocker-Wheeler, Thomson, and Sprague motors having a total capacity of 567.6 horse-power.

In reference to the cost of operation and charges, it may be stated that for motors of 100 horse-power the charge is $21.75 per horse-power per annum, the cost increasing as the size of the motors decreases, to 1-horse-power motors, the rate for this size being $65.50 per year. The above rates are for a daily use of 12 hours, while for use 24 hours per day the rate is increased by 50 per cent, and 30 per cent for a daily use of 18 hours.

For water power, consumers are charged $98 per year per cubic foot per second at a head of 80 feet. The charges for boat traffic are $12.50 per boat per year for 5-ton boats and $20 per boat per year for 10-ton boats, passenger boats being $15 per year and row-boats $5 per year. The tolls for passenger and row-boats at the Fushimi and Ke-age inclines are 7½ and 15 cents per boat.

The first cost of construction of the Lake Biwa canal was nearly three-fourths of a million dollars, while the electric plant cost about one-third of a million dollars. Of the latter sum, enough has been repaid to reduce the same to $207,500, and as 70 per cent of the net profit is set aside for the purpose of repaying the investors, while 3 per cent is reserved as a maintenance fund, it is stated that by the end of 1909 all of the original investment should be repaid.

The total annual income for 1902 of this plant was $84,526.05, including the income from passenger and freight boats, from water-power supply to consumers as well as income from electric-power and lighting service.

* Specially prepared for the Scientific American Supplement.

THE CARBURETING OF HEAVY OILS.

By R. Desmarest.

For several years past an endeavor has been made to use kerosene oil instead of gasoline with explosive motors. Accordingly there exists at the present day a considerable number of kerosene carbureters; but, if these are examined separately, one is surprised to see in their construction no following out of the laws which must be complied with in order to make them work satisfactorily.

In reality inventors are always working according to the following considerations: Ordinary gasoline, which has given up to the present the best results as a carburant for explosive motors, is inflammable below 35 deg. C. (95 deg. F.) and distills according to its density, which varies from 0.700 to 0.740 between 70 and 120 deg. C. (158 and 248 deg. F.) Kerosene, on the contrary, only ignites above 35 deg. C.; its density varies from 0.780 to 0.810, and it distills from 150 to 280 deg. C. (302 to 536.8 deg. F.). Therefore it is necessary to heat the kerosene much more than gasoline in order to vaporize it before mixing it with air in the determined proportion necessary to produce a carbureted mixture. Unfortunately, while gasoline, the first product obtained in the distillation of crude petroleum, is a substance having little or no variation in its nature and physical and chemical properties, this is not the case with kerosene. Pelouse and Cahours, while studying American petroleum, were able to isolate and examine thirteen hydrocarbides whose chemical formula varied from C_4H_4 to $C_{16}H_{34}$ saturated, in a single series of those which boiled at a temperature below 300 deg. C. (572 deg. F.). It can easily be seen, therefore, that a carbureter which will work perfectly with a distillate of given density will not work at all, or will work very badly, with some other distillate. It is therefore indispensable not only to study thoroughly the physical conditions of the heavy oils, but also to take notice of the desiderata that should be realized when using such combustibles in order to obtain regular operation with the maximum efficiency possible and without any drawbacks.

From the experiments made at the test at Meaux on Russian petroleum, the following general physical characteristics were obtained:

Density at 15 deg. C. (59 deg. F.), 0.823.

Temperature necessary in order that the heated petroleum in the presence of air should cause an explosion, 48.2 deg. C. or 118.76 deg. F.

Flashing point, 54.3 deg. C. or 129.74 deg. F.

Calorific power per kilogramme, 11,040 calories.

Calorific power per pound, 5,007.71 calories.

According to the same author, the theoretical quantity of air necessary to the combustion of 1 kilogramme of petroleum was 15.1 kilogrammes, or 1.7 cubic meters (60 cubic feet, or 27.23 cubic feet of air per pound of petroleum). We shall see that this proportion is not altogether exact. In any case this proportion varies considerably according to the density of the petroleum utilized.

The numerous studies that have been made with respect to carburetion have permitted the determination of the following general laws: (1) The composition of the carbureted mixture must be altogether constant; (2) the carbureted mixture must present a perfect homogeneity; (3) the combustible must be maintained in suspension in the air in a gaseous state or in a state of saturated vapor; (4) the state of the mixture or its composition must remain invariable from the moment when it is formed to the moment when it is ignited; (5) the composition of the mixture must be absolutely invariable whatever may be the amount supplied to the motor; (6) the carbureter must be so constructed that the carbureted mixture can be completely formed during the length of the aspiration stroke of the motor.

Finally, it should be recalled as one of the capital laws that the following principle conforms to the prescriptions of the theories of the Carnot cycle, or of maximum efficiency, and that it is applied particularly to thermic motors.

In order for a combustible to produce a maximum thermic effect, it is necessary that its combustion shall be complete at the highest temperature possible; it is also necessary, at the moment of ignition, to have had its constituent elements dissociated, transformed into a gaseous or gasiform state, and put into intimate contact with the quantity of the carburant strictly necessary to the combustion.

We shall now examine successively these different laws from the point of view of their application to kerosene, and we shall indicate the principal causes of failure of the apparatus constructed up to the present, endeavoring to be as clear as possible in order that our explanation may be comprehended by all.

(1) The composition of the carbureted mixture must be constant.

The truth is, that, although the authors content themselves with enunciating this definite law, it is inexact (as well for gasoline as for kerosene), for it is indispensable to add "for identical conditions of operation," that is to say, for the same temperature and the same hygrometric state of the atmosphere; for a given motor turning at a given speed and operating at a given efficiency, the proportion of the combustible with respect to the air must be always exactly the same.

We shall endeavor to demonstrate, while explaining it, the necessity of this first requisite. For a long while, in practice, all chauffeurs have observed the following facts: When the air is very humid, it is necessary to diminish the quantity of air, while when it is very dry the proportion of air should be increased. When starting the motor, especially when the weather is cold, it is often necessary to increase the proportion of gasoline; while when it is warm, on the contrary, this proportion must be diminished. There are numerous cases, as all automobilists know, where the law mentioned above does not hold good, for generally the precaution is not taken of completing it, as we have indicated. Thus the defective enunciation of this principle, admitted and followed to the letter by nu-

merous experimenters, without being analyzed, has led them to construct apparatus, for gasoline as well as for kerosene, where the altogether constant carburetion constitutes a real defect. In reality, it is necessary to combine chemically any hydrocarbide whatever composed of carbon and hydrogen with a proportion of air such that the quantity of oxygen contained in this air will be sufficient to effect the complete combustion of the carbon of the hydrocarbide and to combine itself with the hydrogen so as to form a chemical compound having clearly-defined and invariable proportions of its constituent elements, namely, water. But this air that is borrowed from the atmosphere contains, besides the oxygen and nitrogen which is inert, a certain proportion of humidity, that is to say of water or of hydrogen and oxygen in a quantity varying with the hygrometric degree of the air. Therefore, the final mixture must be forcibly varied according to the quantity of water. Moreover, the hydrocarbide utilized emits vapors whose volume changes according to the temperature, which gives a new cause of variations; and finally, the density of this hydrocarbide varies. For kerosene, these last two causes are of the least importance, but the first takes more considerable proportions because we are dealing with a hydrocarbide which is richer in carbon.

From the above it can be seen that, in order that a carbureter shall be practical, it is necessary to do away with these regulations of the proportion of air and of gasoline—regulations which are extremely delicate and always impossible to obtain with any degree of exactitude. It is, therefore, necessary that the carbureter shall be of the constant carburetion type for fixed conditions and of the regulatable carburetion type for cases necessitating variations in the carburetion, and that all these regulations shall be made exactly, instantaneously, and automatically, as otherwise the apparatus would be impracticable and defective. As for the practical realization of this indispensable automaticity, it will only constitute a real difficulty to those whose knowledge of mechanical matters is too meager to permit them the least conception in this order of ideas.

(2) The carbureted mixture must be homogeneous.

This is necessarily a consequence of the preceding law, for it is easy to comprehend that it would be extremely difficult to maintain a constant carburetion with a mixture having inequalities of composition in its mass. One could not guarantee in this case that the mixture, or, if you wish, the sum of the parts too rich in carbide with those too poor in this same substance, would constitute a total mixture of the proportions desired. Nevertheless, if, as a first condition, the quantity of the combustible and of the air has been exactly proportioned, this lack of homogeneity is not of much importance; and there exists to-day a large number of industrial petroleum motors with which this homogeneity of the mixture is far from being perfect, yet it does not sensibly affect the operation of the motors. The fact should be recognized, nevertheless, that in an automobile motor, the very rapid speed of the motor gives less security in this respect than with slow-speed industrial motors; and, in conclusion, the homogeneous mixture always gives a greater security and diminishes greatly ignition difficulties, while at the same time it gives a more regular operation and a better efficiency of the motor.

(3) The combustible must be maintained in suspension in the air in a gasiform state or in a state of saturated vapor.

And before everything else it should not be forgotten that in the application of carbureted mixtures to motive power, the combustion of the carbureted mixture must be effected. If, on the other hand, we go back to the descriptions of the theories of the Carnot cycle, cited above, it will be seen that this law is that which is of the greatest importance among those which we have designated in this study of carburetion; also, we believe it indispensable to discuss this subject a little, although the theoretical explanation of this principle may be difficult to explain clearly. Consequently, we shall make use of the following comparisons: Suppose a petroleum lamp lighted and that by some convenient means we stop the air from reaching the burner in sufficient quantity. The petroleum, composed of carbon and hydrogen, will combine with the air, composed of oxygen and nitrogen; a part of the oxygen will combine with the carbon and form oxide of carbon, CO; another part will combine with the hydrogen and form H_2O; and finally, a third part of oxygen will combine with the oxide of carbon already formed and will result in the formation of carbonic acid, CO_2. For these different combinations, however, there must be sufficient oxygen; but, the reaction which takes place with the greatest facility is that between hydrogen and oxygen, and if there is not sufficient oxygen to combine with the total amount of carbon, a part of this carbon will be set free and will appear in the form of characteristic black smoke. If the air arrives in a normal quantity, that is to say, if there is sufficient oxygen to transform the total amount of carbon into oxide of carbon, the lamp will not smoke. If, finally, the air is in excess, not only is there a total combustion of the carbon, but there is also a combustion of the oxide of carbon to form carbonic acid, and the lamp not only does not smoke, but the flame loses its luminous character and becomes bluish, at the same time giving forth the maximum quantity of heat. But since there is combustion, the petroleum is forcibly dissociated, that is to say, its constituent elements are separated; this is the consequence of the combustion. On the other hand, it is not indispensable that there should be combustion in order to obtain dissociation of the petroleum, for this substance, heated in a closed vessel without being in contact with oxygen, also becomes dissociated. It can readily be seen, therefore, that if before effecting the combustion of the petroleum, it had been heated and reduced to a superheated vapor at a temperature near that of the point of dissociation (i.e., about 900 deg. C. or 1,652 deg. F.) combustion would have been facilitated thereby and it would have taken place under the best possible conditions.

Petroleum, thus reduced to a superheated vapor and forming an explosive mixture with air, constitutes a mass in which an elevation of temperature of 6.2 deg. from any point whatsoever will cause, with extreme facility, ignition and rational combustion of the mixture. From the above it is easy to comprehend the conditions which a kerosene carbureter must fulfill.

This carbureter must regulate with great exactness the proportions between the quantity of kerosene and air necessary for combustion. In the case of kerosene of 0.810 density, for instance, this proportion would be 1 kilogramme of kerosene to every 16.5 kilogrammes of air. This proportion has almost always been determined empirically by experience, but without following the exact figures. The result is that a large number of carbureters for heavy oil are far from being economical and the combustion obtained with them is incomplete, the free carbon giving place to a fouling of the motor such that all lubrication becomes impossible, the piston rings stick, and the connecting rods have even been known to break. These figures are nevertheless easily obtained by an elementary calculation in chemistry, they being based on the chemical composition of the petroleum utilized and the reaction of this petroleum with the air, a light excess of air, which is indispensable to combustion, being added.

The petroleum must be in the state of superheated vapor. This is in consequence of what precedes, and we will not dwell upon it, but we wish to mention the troubles which the non-observance of this principle causes. If the petroleum is insufficiently heated it does not vaporize, but it can be pulverized. It forms then globoidal vesicles which, upon coming in contact with a heated surface, become heated and take the spheroidal state; the surface alone vaporizes, while the central cores of these vesicles remain at a temperature lower than the point of ebullition. Combustion is consequently incomplete, and the motor becomes fouled. It should here be noted that the petroleum can be perfectly vaporized in the carbureter and yet give place to the above-mentioned troubles. This is because the insufficiently heated petroleum partially condenses during its passage from the carbureter to the motor, or that this condensation is produced in the carbureter itself by the contacting of the petroleum vapor with too cold air. If, on the contrary, the petroleum is gasified to a state of superheated vapor and maintained in this state, it is evident that nothing like this will happen, but that economical operation is obtained, together with a superior efficiency and a total lack of fouling, that great bugbear of all kerosene oil motors.

The carbureter must be so constructed that the temperature necessary for the gasification of the petroleum is obtained. With industrial motors, the simplest system, and that which is most generally used, consists in the employment of a lamp which heats the carbureter. It is easy to regulate this lamp so that it shall give the desired temperatures. With automobile motors the employment of burners or lamps is, of course, impracticable, but the exhaust gases have a temperature of from 700 to 800 deg. C., which is quite sufficient, if the surfaces to be heated are suitably arranged, to vaporize and superheat the petroleum without, however, dissociating it completely. In this case the use of an auxiliary lamp only becomes necessary for a few minutes in starting, or it is possible to construct the carbureter so that the engine can be started on gasoline and run until the necessary temperature is obtained in a few minutes in the exhaust pipe. Several carbureters have been constructed on this plan, but, besides the defects mentioned above it is difficult to start the motor with many of them. The cause of these difficulties resides simply in a bad proportioning of the heating portions which, not having a sufficient volume, will not store up rapidly and hold for a sufficiently long time the quantity of heat which is furnished.

Finally, it is necessary to evade, especially in winter, utilizing too cold air for forming the carbureted mixture; it is, on the contrary, advantageous to employ air already warmed, for it is easy to comprehend that, by this very means, vaporization is facilitated, and all danger of any troublesome condensation of petroleum is avoided.

(4) The state of the carbureted mixture or its composition must remain invariable from the moment it is formed until the moment it is ignited. This principle has been explained by what precedes, so we will not dwell upon it.

(5) The composition of the mixture must be absolutely invariable whatever may be the speed of the motor.

It goes without saying that this is understood for clearly determined conditions of temperature and hygrometry of the air, and for a given motor and combustible. According to the principle of the explosive motor, it is necessary that the combustion of this explosive mixture be made under the best possible conditions; it is therefore indispensable that it should present a normal composition, for otherwise there would be either incomplete combustion, bad efficiency, and fouling, or no combustion at all. It is therefore necessary that the composition should be invariable; but as it is evident that a slow-running motor produces less power than if it is running rapidly, it is necessary that the expense of the motor agent be less at low speed than at high speed; it is therefore advantageous, and even indispensable, to regulate the speed of the motor not by acting on the composition of the carbureted mixture, but by causing the quantity of this mixture admitted to the motor to vary. Hence, the necessity of having a throttle valve acting mechanically and varying the admission of the carbureted mixture to the motor.

(6) The carbureter must be so constructed that this carbureted mixture can be completely formed during the aspiration stroke of the motor. Suppose a four cycle motor to be running at 800 revolutions per minute; there will be an aspiration every two revolutions, or 400 aspirations per minute; but as this aspiration is produced only during the descent of the piston, or during one-half a revolution, it will last but 0.37 second and, for an engine making 1,600 R.P.M., the aspiration stroke will last only 0.18 of a second. All gasoline carbureters fulfill this condition, and there should therefore not be any difficulty in realizing the same thing with a heavy oil carbureter; but it is necessary that the heavy oil should be reduced to a state of superheated vapor before forming the carbureted mixture, and it is not the duration of the passage of a part of this vapor in a short space of time which it is necessary to consider, but rather the formation of this vapor under the best possible conditions. Now, the less petroleum there is to vaporize, the more rapidly will this vaporization be obtained. Therefore, it is essential to have reach the vapor only the smallest possible quantity sufficient for the operation of the motor. It is advantageous to heat the petroleum progressively and to bring it to a temperature near that of its temperature of vaporization, in order to insure the vaporization and superheating of it in the minimum time. By this progressive heating the main causes of fouling are done away with, for, in the majority of kerosene oil carbureters, the too rapid production of the petroleum vapor sets up a gaseous current sufficiently intense to carry along with it through the carbureter and even into the motor carbonaceous particles.

Finally, if account is taken of the fact that the two combustibles, kerosene and gasoline, possess the same number of calories, and that the air necessary to form the carbureted mixture with gasoline takes away 33 per cent. of the specific power of the motor, while that required in the formation of the carbureted mixture with the kerosene only takes away 18 per cent of the energy, there is from this fact to the advantage of kerosene a 13 per cent. greater efficiency than can be obtained with gasoline.

In ordinary practice, it is true, this theoretical figure of 18 per cent is reduced to 10 per cent; but even at this there is, it will be seen, a marked advantage in favor of kerosene oil. —Specially translated from L'Automobile for the SCIENTIFIC AMERICAN SUPPLEMENT.

NEW LIQUID AIR USES.

PROF. DEWAR'S DISCOVERIES.

PROF. DEWAR demonstrated at the Royal Institution some further discoveries of the peculiar absorptive properties of charcoal under the influence of liquid air.

As long ago as 1684 Boyle had fundamental notions of this valuable property of charcoal. A century later an Italian discovered that it would absorb gases. Priestley, Graham, and Hunter went further, and found that charcoal would take up coloring matter from water. Then came its use in the common filter.

Prof. Dewar has discovered that, as the temperature of charcoal is reduced, its absorptive power is increased. He has found that under the influence of cold set up by liquid air and liquid hydrogen, the charcoal will absorb all the air or gases around it, and, if inclosed, will produce a very high vacuum. This was illustrated by means of Sir William Crookes's radiometer. Over thirty years ago Crookes showed that delicately-poised vanes would revolve in a high vacuum when light fell on their blackened sides. Taking a radiometer with the bulb containing air, and connecting it with charcoal, reduced to the temperature known as minus 185 deg. C.—or in popular language to about 333 deg. Fahr. of frost—the bulb immediately became a high vacuum, the air being absorbed by the charcoal, and the vanes spun round at a rapid rate. In another experiment phosphorus was placed in a small bulb above another filled with oxygen—both substances being quite dry. In this condition the phosphorus will not ignite. Then the oxygen was connected with charcoal, chilled by liquid air; the bulk of it was absorbed by the charcoal, the phosphorus became gaseous and combined with the oxygen, and made the bulb luminous—showing that at the temperature of liquid air substances will combine chemically even without moisture. Finally the professor took a radiometer filled with helium, and on this charcoal cooled by liquid air had no effect. He then plunged the carbon into liquid hydrogen at the temperature of 20 deg. C. absolute—20 deg., that is to say, above the point at which all heat would be abstracted—or to a point equal to about 456 deg. of frost. Instantly the helium began to be absorbed by the charcoal, a vacuum was formed, and the vanes of the radiometer spun round rapidly. It would seem that here we have a fresh instrument of research, and a new means of separating from the air those rare ele-

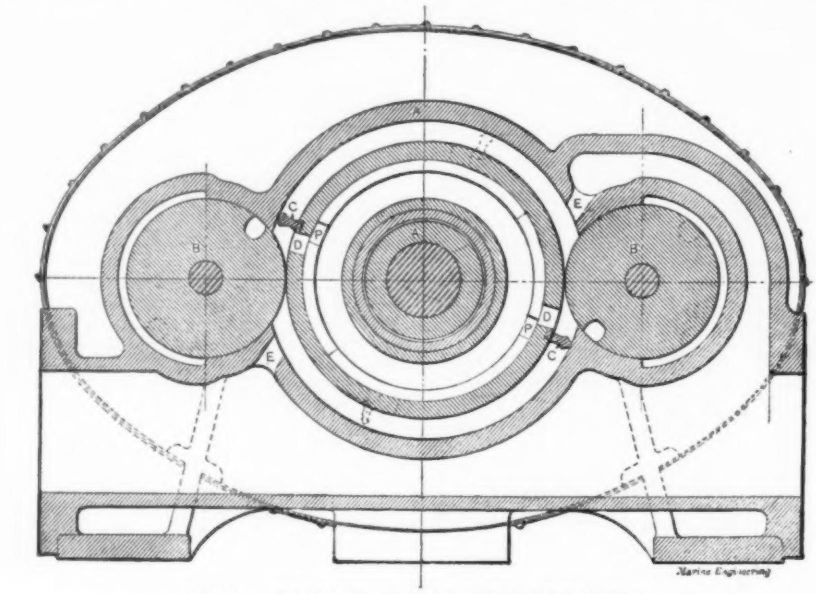
mentary gases recently discovered—argon, helium, neon, xenon, and krypton.

A NEW ROTARY ENGINE.

Some years ago a young inventor, Edward C. Warren by name, who was much interested in rotary engines, determined to make a thorough study of the history of rotary engines as described in the different United States patents granted on this subject. This study was undertaken with the object of discovering just what were the principal obstacles in the way of building a thoroughly practical rotary engine. The most serious difficulty revealed by his search was that of preserving a steam-tight joint between the rapidly rotating piston and the stationary cylinder without entailing too great loss by friction and its attendant heat. In reciprocating engines steam-tight joints are maintained by the use of suitable packing, and the friction is reduced to an economical figure by the use of lubricants. But the highest speed at which it is considered safe to operate a tight piston falls far short of the speed required of the ordinary rotary-engine piston, which must travel at the rate of three thousand feet per minute and over. This obstacle discovered, Mr. Warren made a study of friction, its laws and causes, to discover, if possible, a practical means by which the difficulty could be overcome. Friction between two bodies occurs, of course, only when these bodies are in contact with each other, and is increased by the pressure applied, this being due to the fact that pressure merely increases the surfaces of contact and causes the tiny projections which are found on the smoothest of surfaces to move into closer interlocking engagement with each other. Theoretically, it would be possible to obtain steam-tight joints without bringing the two bodies into contact with each other, that is, a very close running fit would prevent the passage of steam, provided the clearance between the two surfaces was infinitesimally small, and, as long as such a clearance actually existed, there would obviously be no friction. In order to produce these theoretical conditions, the bodies must have theoretically perfect smooth surfaces, so that a uniform clearance between them would be maintained.

With these theoretical considerations in mind, the young inventor set about the construction of a rotary engine which would embody these ideas in practical form. The result of his labors is illustrated in the accompanying engravings, which also reveal the careful design of the machine. The construction of the engine is more clearly shown in the cross section. It will be observed from this view that the engine comprises a central piston, operating between oppositely-disposed rotary abutments, which are rotated in the usual manner by suitable geared connection with the central piston. The piston comprises a drum with flanges at each end and one in the center, between which the blades or vanes are mounted. The blades are turned off flush with the flanges of the drum, and the entire piston is slightly tapered to fit the tapered bore of the casing. Due to the slight difference in diameter between the two ends of a piston, the pressure of the steam which is introduced into the piston produces a slight end thrust upon the flanges and the main shaft, which causes the tapered piston to move more closely into contact with the casing. This results in producing a tight joint between the casing and the flanges and blades of a piston. To counteract this end thrust and maintain the desired clearance between the parts, a thrust bearing is mounted upon the shaft at one end, by which the necessary adjustment may be made. In case of any wear between the piston and the casing, which in practice is sure to exist, this will be compensated for by the friction on the thrust bearing, which permits the piston to move further into the tapered bore. It will, of course, be understood that the friction on the thrust bearing is very slight, owing to the fact that the peripheral speed of the shaft is small and the bearing is thoroughly lubricated. It will be observed that the abutments are provided with peripheral notches, to receive the vanes or blades of the piston. The vanes enter these notches without coming into actual contact with the abutments, as a close joint is not here needed. It is evident that steam bearing against the face of each abutment at the inner side tends to press the abutment outward. This pressure would cause the bearings of the abutment to wear away in time, and thus destroy the close fit between the abutment and the face of the drum. To counterbalance this pressure, a small piston is provided, which is acted upon by pressure of the steam in the engine, and bears against one arm of the lever, whose other arm presses against the shaft of the abutment. The pressure on the piston will, of course, vary with the steam pressure on the inner side of the abutment, but the parts are so arranged that there will be a slight excess of inward pressure, so as to hold the face of the abutment close to the face of the drum. The abutments are geared to make two rotations to one of the drum. The peripheral face of the drum, however, is not twice that of the abutments, so that these surfaces have a grazing or sliding contact instead of a rolling contact. This permits them to wear away slowly, to compensate for the unavoidable wear on the journal. The journals of the abutments are so designed as to permit axial movement of the abutments, and the latter being held between flanges of the piston, are caused to move with the piston as it automatically adjusts itself in the tapered bore of the piston. In this manner the necessary wear at one part of the engine is compensated for by the wear at another part, and pressure at one point is counterbalanced by pressure at another. The parts are thus kept in close engagement with each other, but without being under unequal pressure sufficient to produce any appreciable amount of friction. An examination of the rotary engine, after it had been in operation for a time, revealed a high polish at all points of contact.

The operation of the machine can be readily understood by a study of the diagram. Steam is admitted into the interior of the drum, whence it passes into the working chambers of the piston through the ports in the drum. The vanes of the working chambers are spaced alternately ninety degrees apart about the drum. This insures a more uniform action of the engine. The valves of the drum ports are formed by hub extensions of the casting heads, which project into the interior of the drum and provide a positive cut-off. A close fit between these hubs and the inner face of the drum is not required. The hubs being stationary will always maintain their original position, and will serve to counteract the lowering of the piston due to wear of the journals, by permitting an increase of leakage into the lower working chamber and a corresponding decrease of leakage in the upper chamber. The difference in pressure thus created would soon become sufficient to support the weight of the piston and prevent further wear on the journal. Mr. Warren's engine has been thoroughly tested and has given very satisfactory results, the piston rotating at peripheral speeds up to five thousand per minute with perfect smoothness.



CROSS SECTION OF THE ROTARY ENGINE.

A NEW TYPE OF ROTARY ENGINE COUPLED TO A DYNAMO.

ELECTROTYPING.*

By Dr. F. Mollwo Perkin.

No one has been long in a chemical laboratory without having learnt that one of the simplest tests to ascertain whether a solution contains copper is to place the blade of a pen-knife into it. If copper is present the blade of the knife becomes covered with a thin coating of copper. Other metals besides copper can be plated out upon another metal by simply immersing it in their solutions. For example, if a silver article is dipped into a solution containing a gold salt, it will become covered with a thin coating of gold. This process of dipping is to a certain extent actually performed in practice, hence one is accustomed to talk of giving an article a gold wash. For example, at one time the method employed for gilding the inside of silver boxes, the bowls of spoons, etc., was to wash them over with a piece of rag which had been dipped in the gold solution. When a metal is plated by simply immersing it in the solution of the other metal, then an equivalent of the metal which is being plated upon goes into solution. Thus, when the blade of a knife is placed into a solution of a copper salt and becomes superficially coated with copper, it is only done at the expense of a portion of the blade which goes into solution. Supposing the solution to consist of copper sulphate, then as copper is deposited out, sulphate of iron takes its place. Thus we can write it in the form of an equation:

Copper sulphate + iron = iron sulphate + copper or by using symbols

$$CuSC_4 + Fe = FeSC_4 + Cu.$$

The metal which goes into solution and upon which the other metal becomes plated out is said to be electro-positive to the metal in solution. Zinc is the most electro-positive of all metals, and under appropriate conditions is able to replace all other metals from the solutions of their salts.

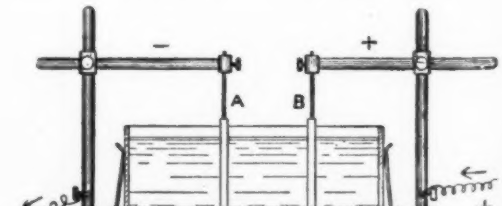


Fig. 1.

Now this method of plating or depositing out a metal has only a very limited application. It is used to a certain extent in gold plating, but not for depositing such a metal as copper. The methods employed are electrolytic. It is found if an electric current is passed through a solution of a metallic salt, e. g., copper sulphate, that the copper is deposited out upon the one electrode,† and at the other electrode if it is of an insoluble material, such as platinum or graphite, oxygen gas is evolved. The pole at which the metal is deposited is called the negative pole or cathode, the one at which oxygen gas is evolved, the positive pole or anode. Fig. 1 shows such a cell diagrammatically.

* Knowledge & Scientific News.

† When two pieces of metal connected with the opposite poles of an electric battery are immersed in a solution, as shown in the figure, these pieces of metal are called electrodes.

A is the negative electrode or cathode (—) and B is the positive electrode or anode (+).

If instead of being made of an insoluble material the anode B consists of a sheet of copper, then as the electric current passes the copper will go into solution. Furthermore, the copper will pass into solution at the same rate as the metal is plated out upon the cathode A; theoretically, therefore, the strength of the solution will remain constant. As a matter of fact, owing to secondary changes, after a time it becomes too concentrated.

Electroplating was first suggested by Elkington in 1836, but he did not apparently employ it on an industrial scale. It is very interesting to note that some of the articles obtained from the coffins of the Egyptian mummies have been found to be coated with copper; probably, however, the coatings of copper in these cases were produced by simple immersion. On an industrial scale electroplating was first introduced by M. H. Jacobi, of St. Petersburg, in 1838. Since then, especially of late years, an enormous industry has been developed. By simple immersion heavy deposits of metal cannot be obtained, but coats of any thickness can be produced by electro-galvanizing. In this article it is intended to deal not with plating in general, but with the application of the electric current for producing electrotypes or reproductions; this form of electrodeposition is sometimes called galvanoplastic.

In all cases of reproduction the article to be reproduced is made the cathode in a bath of copper sulphate, and a strip of copper the anode. Now, supposing it is desired to reproduce a medallion; if this be of metal and is made the cathode, copper will be deposited upon it, but the copper will adhere so firmly that it will be impossible to remove it. It is, therefore, necessary to coat the medallion with an extremely thin film of some material which will prevent the deposited metal from adhering to the metallic surface. This coating must not be sufficiently thick to obliterate or blur the details of the figures, etc., upon the article which it is desired to reproduce. There are several methods which may be employed. If the medallion is of silver or copper, its surface after being carefully cleaned so as to remove dirt or grease, is washed with a solution of sodium sulphide, by which means the surface of the metal is coated with an extremely thin film of sulphide of the metal. This surface is conducting, but prevents the deposited metal from adhering to the article. Another method is to cover it with a thin coating of black lead (plumbago). The coating must be very thin and should be polished in much the same way as the iron-work of a fire-place is polished. In practice, machines are generally used for polishing and plumbagoing surfaces, as it is not an easy matter to get a perfectly smooth and even surface by hand.

Having satisfactorily prepared the surface of the article, it is hung by means of a copper wire in the depositing bath and connected with the negative pole of the source of current. The conducting wire where it dips below the surface of the copper solution should be covered with an insulating material, such, e. g., as a piece of rubber tubing. As soon as the circuit is closed and the current passes, the surface of the article becomes coated with a thin film of copper, which gradually increases in thickness, until a coating of about one-fourth to one-half a millimeter in thickness has been obtained. It should be mentioned that the back of the article is coated with some non-conducting material, such as solid paraffin wax, otherwise the whole article would become covered with copper, and it would then be impossible to remove the deposited metal. In depositing the metal certain precautions have to be taken. Thus, for example, the regulation of the current strength (current density) is a matter of great importance. If a heavy current is employed, the copper is very apt to be deposited in a rough and irregular form, and may be so powdery as to actually rub off. The color of the copper is bright, and the appearance smooth and regular when low currents are employed, but it is rough and brown (burnt) with currents of too great intensity.

When a sufficiently thick deposit has been obtained the article is removed from the bath, well washed with water, and dried. The point of a pen-knife or other sharp instrument is then inserted under the edge of the deposited metal and the metallic coating carefully stripped from the article upon which it has been deposited. Sometimes it is rather difficult to strip it without bending and injuring the thin metallic shell, and when this takes place it is not by any means an easy matter to properly smooth it out again. The thin shell thus obtained is backed up with lead or with an alloy of lead, which melts at a lower temperature than the lead itself. In order that the backing metal may adhere satisfactorily, the back of the shell must first be tinned; a satisfactory tinning mixture consists of an alloy of 50 parts lead and 50 parts tin. The backing metal is then run in; a useful alloy for this purpose consists of 90 parts lead, 6 parts antimony, and 4 parts of tin. Wood's alloy is sometimes used, but is too expensive for ordinary practice. It consists of an alloy of lead, tin, cadmium, and bismuth, and melts below the temperature of boiling water.

A complete copy of a medal can be obtained by depositing the metal first on one side and then on the other. The two shells thus obtained are, after tinning, placed back to back and the fusible alloy run in between them. After filing and polishing the edges, copper can be deposited on the rim when the whole—reproduced—medal appears to be composed of copper.

Another and more commonly employed method is to make a cast or matrix of the object which it is desired to reproduce. This may be done in a variety of ways. Sometimes a metallic cast is made directly from the die, and upon this cast a thin film of copper is deposited.

Another method, and the most usual, is to prepare a plaster cast and render this impervious to water by impregnating it with melted paraffin, after which the surface is coated with graphite to make it able to conduct the electric current. Sometimes instead of graphitizing, it is coated with a thin film of silver by chemical means. After having been rendered conducting, the cast is made the cathode in a plating bath and metal deposited as already described. When a sufficiently thick deposit has been produced the cast is taken out of the bath, the deposited metal removed and backed up as already described. The deposited metal gives a faithful reproduction of the original medal.

Instead of using plaster to make the cast, gutta-percha or mixtures of gutta-percha and other substances are often employed.

A SIMPLE, EFFECTIVE, AND INEXPENSIVE LIGHTNING RECORDER.

By HENRY F. ALCIATORE.

IN the latter part of August, 1902, the writer, at his own expense, constructed and erected in the local office of the United States Weather Bureau in New Orleans, La., a lightning recorder which has proved fairly satisfactory. Our object was to obtain automatic records of the hundreds of electric discharges, visible and invisible, that usually precede and accompany thunderstorms, and to study the same with a view to increasing the accuracy and value of local weather forecasts.

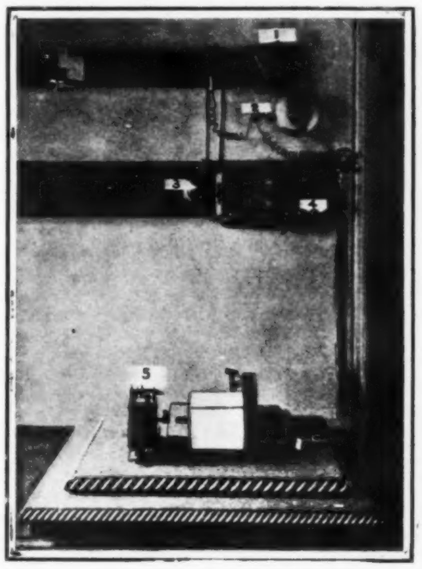


FIG. 1.—LIGHTNING RECORDER.

1, decoherer; 2, coherer; 3, cut-out; 4, relay; 5, recorder.

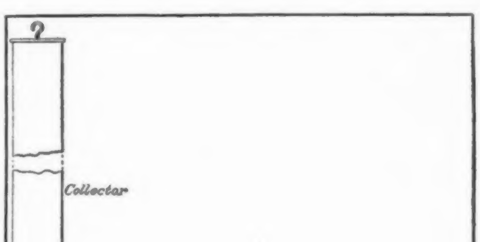


FIG. 2.—DIAGRAM OF THE LIGHTNING RECORDER AT NEW ORLEANS, LA.

d, double connector; B, battery; C, coherer.

The action of the instrument is based upon the effect that high-tension electric waves in free air, such as lightning, have upon metal filings suitably arranged in a glass or other insulating tube between two metal electrodes, one of which is connected to a collector above the ground and the other to the earth. In their normal state the filings rest loosely at the bottom of the tube between two electrodes about one-sixteenth inch apart, and their electrical resistance is comparatively high. Now, when lightning occurs in the vicinity of the filings some of the electric waves traveling through the air pass through the filings from one electrode to the other; this causes the filings to stick together and their electrical resistance is greatly reduced, thereby rendering it possible for the current from a local battery to operate a relay in circuit with the filings, which in turn operates a device that separates the filings and restores them to their original condition, and at the same time records the passage of the electric waves.

Two years' experience with the lightning recorder described below has demonstrated that lightning records can be used to some advantage in making local forecasts. If, for instance, the recorder ticks frequently on a clear summer morning when there are no visible signs of an impending thunderstorm (each tick represents an electric discharge somewhere near the station, may be only a mile distant and may be 50 miles away) we conclude that the condition of the atmosphere is unstable, and that some time during the day there will be a thunderstorm. On July 3, 1903, for example, the first signal occurred at 5:21 A. M., and the first audible thunder at 12:40 P. M., or seven hours and nineteen minutes later. The last thunder occurred at 3:00 P. M., and the last signal at 3:53 P. M. About 180 signals were recorded by the instrument before the first audible thunder. In its present crude condition our recorder can not tell us from what direction the storm is approaching the station, nor with what speed and intensity, but by improving it such information may some day be obtained.

Among those most interested in forecasts of thunderstorms are the owners of extensive electric light and power plants, wherein thousands of dollars' worth of electric machinery is at the mercy of a stroke of lightning. While a lightning recorder can do nothing, directly, to prevent the coming of the destructive bolt, yet if a superintendent knew some hours in advance that a storm was coming he could prepare himself, and would have certain advantages over one taken unawares. This information the United States Weather Bureau may some day be able to give.

For the benefit of those who desire to take up this interesting work the writer gives below a description, with approximate cost, of a simple, practical, and inexpensive lightning recorder, which can be made and installed by any one having an ordinary knowledge of electricity, and which will give warning of approaching thunderstorms anywhere from a few minutes to several hours in advance of the first peal of audible thunder. The instrument at New Orleans consists of—

THE COLLECTOR.

The collector is a hollow cylinder fourteen feet long and eleven inches in diameter, made of two sheets of commercial zinc nailed to three disks of wood, one at each end and the third in the middle. The edges of the zincs are soldered. There is an eye hook at the top of the guy lines and a ¼-inch bolt, about two inches long, at the bottom, which fits into an ordinary telegraph glass insulator, fixed to a six by six wooden board one inch thick nailed to the floor of the platform, upon which the collector stands in an upright position. The top of the collector is about 110 feet above the ground. Cost, about $3.

THE COHERER.

The coherer consists of a piece of thick glass tube, one-quarter inch inside diameter, two inches long, into which are closely fitted two silver electrodes each one-quarter inch in diameter and three-eighths of an inch long, with a piece of copper wire soldered to each. The electrodes are about one-sixteenth of an inch apart. In the space between them are placed a few filings filed from a 10-cent piece of money with a coarse file. A dime piece will give enough filings for a dozen receivers. The spaces back of the electrodes are filled with plaster of Paris, to keep the moisture out. This coherer can be refilled at a cost of about two cents. Cost, about $1.

THE DECOHERER.

The decoherer is an ordinary 3½-inch doorbell, to the hammer of which is soldered a stout piece of wire, two inches long, at right angles with the axis of the hammer, and to which the coherer is attached by a piece of insulating tape. When the bell rings, the filings are shaken and separated. Cost, about $1.50.

THE RELAY.

The relay is of the ordinary kind used in telegraphy and has a resistance of about 150 ohms. Cost, about $5.

THE FUSE.

This is a piece of 2-ampere fuse, about three inches long, such as is used in electric light circuits. Cost, about five cents.

THE GROUND.

A sewer, gas, or water pipe, of metal, under the ground, or a small piece of metal buried in the earth will answer for a ground.

THE CUT-OUT AND DOUBLE CONNECTORS.

A small cut-out, with ebony handle, such as is used in electric light wiring, and two double connectors of

the kind used in telegraphy are used. Cost, about fifty cents.

THE BATTERIES.

Two batteries are used, one of two dry cells for the coherer and one of four dry cells for the decoherer and recorder circuits. Cost, about $1.80.

THE WIRES.

A piece of No. 10 weather-proof, electric-light wire, to lead from the collector to the coherer, and a supply of office bell wire for office connections. Cost, about $1 for ordinary installations.

THE RECORDER.

The recorder consists of a strong clockwork; a hollow wooden cylinder, three and a quarter inches in diameter and three and a quarter inches long, mounted on an endless screw fixed to an upright iron support at one end; and a small door-bell magnet, on whose armature is soldered a self-inking pen made of a hollow brass cone about one-quarter of an inch in diameter at the base and one inch long. The cylinder carries a sheet of paper divided into hour and 5-minute spaces and makes a complete revolution once every hour. A fresh sheet is placed upon the cylinder every twenty-four hours. Every time the recorder ticks, the pen, which is suspended over the cylinder about one-sixteenth of an inch therefrom, strikes the paper and imprints thereon a dot. Cost, about $15.

ARRANGEMENT OF CIRCUITS.

The collector is on the roof of the building; the rest of the apparatus is in the office room.

Collector circuit.—Run a wire from the lower end of the collector to the fuse box; thence to double connector No. 1; thence to coherer; thence to double connector No. 2; thence to the ground.

Relay circuit.—Run a wire from double connector No. 1 to the cut-out; thence to relay post No. 1, also a wire from relay post No. 2 to battery No. 1; thence to double connector No. 2.

Decoherer and recorder circuit.—These instruments are in series. Run a wire from relay post No. 3 to the decoherer; thence to the recorder; thence to battery No. 2; thence to relay post No. 4.

The wire leading from the collector should be nailed to the lower end of the collector and soldered thereto. The wires leading to the coherer—about one foot on each side—should be flexible, so that they will not interfere with the movements of the decoherer. The decoherer should be tilted to one side—the side away from the hammer. As there is a small current passing through the coherer constantly, sooner or later it will "stick"—that is, refuse to work. Therefore it should be given a rest as often as possible by cutting it out or putting in one of the extras. Sometimes the decoherer bell will ring once and sometimes it will ring several times, according to the intensity of the lightning discharges. Closed-circuit batteries will last longer than open-circuit ones.

Dr. Lee DeForest, of the American DeForest Wireless Telegraph Company, during a recent visit to New Orleans, suggested to the writer the advisability of thoroughly insulating the coherer wires from the walls of the building.

Summarizing the results obtained so far it may be said that:

1. A practical lightning recorder can be made at small cost that will give results fully warranting the cost of construction.

2. Where written signals are not required, the bell on the decoherer can be utilized for giving audible signals; and the cost of the apparatus greatly reduced.

3. The recorder will not tick merely because the sky is cloudy and threatening; in cloudy weather it will give signals only when barometric and other atmospheric conditions favor the formation of thunderstorms. In storms coming from a great distance signals were recorded with a clear sky.

4. In most cases, frequent signals in the early forenoon indicate that a thunderstorm will occur later in the day. In some of the thunderstorms of which we have obtained records, the first peal of thunder heard at station was preceded by an hundred or more signals.

5. The collector described above is not an element of danger to the station. It will not attract lightning any more than an ordinary smokestack similarly exposed.

6. The cost of operating the lightning recorder need not exceed that of operating two large-sized doorbells.

7. Generally speaking, the higher the collector stands above the ground the larger will be its range of action.

In working out the mechanical details of the recorder the writer received valuable assistance from Mr. F. W. Ax, of the New Orleans office force.—Monthly Weather Review.

THE THEORY OF THE INCANDESCENT MANTLE.

By Vivian B. Lewes, Professor of Chemistry, Royal Naval College, Greenwich.

Ever since the epoch-making discoveries of Baron von Welsbach, which commenced in 1885 with the method of forming a mantle of refractory oxides that should fit the flame, which were continued by the discovery in 1886 of the transcendent virtues of thoria as a mantle basis, and which culminated in 1891-2 in the still more wonderful discovery of the power exercised by a trace of ceria in awakening the marvelous power of light emissivity which the mantles of to-day possess, speculation has been rife as to the causes which lead to the incandescent mantle giving us 20 candles of light per cubic foot of gas consumed, instead of the small fraction of that amount obtainable when we rely upon the incandescence of carbon particles in the flame for the production of light.

From the time when Murdoch first showed the wonders of his "flame without a wick" to the admiring rustics of Redruth, down to the present day, the source of the light emitted by an ordinary hydro-carbon flame has afforded a happy hunting ground, as well as battlefield, for scientific observers; and although everyone now admits that it is the incandescence of minute carbon particles within the flame that emits the light, diversity of opinion still exists as to several minor points, while the incandescence of the mantle offers a still wider field for speculation and research.

It was the discovery of the lime-light in 1826 which first called attention to the great light-giving power of certain unburnable refractory substances, when heated to a high temperature; and Goldsworthy Gurney having shown that a lime cylinder could be raised to incandescence by the flame of the oxy-hydrogen blowpipe, Drummond utilized the light shortly after in a survey of Ireland, and from that day to this it has been a faithful servant to the lanternist when the electric arc was unavailable.

It is clear, however, that the heat required to raise such a mass of material as the lime cylinder to incandescence is very considerable, as radiation and conduction both tend to dissipate the heat, and prevent the necessary temperature being reached.

That this is so can at once be seen by holding a coil of thick platinum wire in a Bunsen flame, when the metal is hardly heated to visible redness; a wire of medium thickness, however, is quickly raised to bright redness, while a thin wire is rapidly raised to incandescence, and in a few minutes melts in certain parts of the flame.

Realizing this, attempts were made to reduce the size of the mass to be heated, and buttons of zirconia and of magnesia were, for a short time, used for street lighting in Paris, an oxy-coal gas flame yielding the necessary temperature. The high cost and constant renewals needed, however, soon led to the abandonment of this attempt at incandescent lighting, and the next step forward was the discovery by Talbot in 1835 that even the feeble flame of the spirit-lamp sufficed to heat lime to high incandescence, if only it could be sufficiently finely divided, and this he did by soaking blotting paper in a salt of calcium and incinerating it.

Up to this time it was only the spirit-lamp and oxy-hydrogen blowpipe which gave flames free from carbon particles, but in 1848, Gillard introduced the intermittent process of making water gas, and desiring to use it for lighting as well as heating, made a mantle of fine platinum gauze to fit the flame. For a time he obtained excellent results, but the surface of the metal soon became eroded by the flame gases, and the light-giving power fell to a useless point, and although inventors have resuscitated the platinum mantle in various forms since Gillard's early attempts, the same trouble has in every case proved fatal.

Early in the fifties, the idea of making a non-luminous gas flame by mixing coal-gas with a certain proportion of the air needed for its combustion before burning, led Bunsen to enrich the gas industry with the burner which bears his name. The construction of the atmospheric burner really marks an epoch in the history of the gas industry, second only to the discovery of the mantle to use with it, as it opened up a field for gas for heating purposes, which is now almost as important as for lighting.

Early in the eighties, the idea of the incandescent mantle again came to the front, and the Clamond basket and a revival of the platinum mantle paved the way to the discoveries of Dr. Auer von Welsbach, which were destined to revolutionize our methods of gas-lighting, and even gas manufacture.

Dr. Auer was, in the early eighties, studying the reactions and separations of the rare earths, in which spectroscopic determinations play an important part; and desiring to obtain a greater illuminating effect than was produced by placing some of the material on platinum wire, tried the effect of impregnating cotton with a solution of the metallic salt, and then burning it in a Bunsen flame, when he found that the organic matter burnt away and left a perfect image of the cotton fibers, composed of oxide of the metal taken, and that this oxide skeleton glowed brightly in the flame, this being especially the case with lanthana, which emitted so much light that the idea entered his mind of using a cotton fabric impregnated with a salt of lanthanum for practical lighting. This, however, proved a failure, as the oxide absorbed moisture and carbon dioxide from the air, and rapidly crumbled away. A mantle of magnesia and lanthana was then tried, but, although it gave a good light, it soon became fused and glassy on the surface, and the light given diminished very rapidly. Zirconia in admixture with some of the rare earths was next tried, and better results obtained, as the result of which the 1885 patent was taken out.

Continuing his experiments, Dr. Auer found that the oxide of the metal thorium—thoria—when added to other oxides of the rare earths, brought up their light-giving power, and also added to the strength of the mantle, but although the use of thoria was protected by the 1886 patent, the mantles were so unsatisfactory that no success was achieved with them, and no uniformity of result could be obtained. For several years it looked as if incandescent mantle lighting was to be a dismal failure, but then Dr. Auer made a research upon thoria, and found that the more he purified it, the less light did mantles made with it give, and finally came to the great discovery that it was an admixture of a trace of ceria with the thoria which endowed it with its wonderful power of emitting light. This led to the adoption in 1892 of the mixture of 99 per cent. thoria and 1 per cent. ceria, a mixture which the thousands of attempts made since have failed to improve upon.

The oxides to be used in the form of mantles must have certain qualifications which are very difficult to find, hence the number usable is very limited. The oxide must be unaffected by atmospheric influences, must be sufficiently refractory not to melt or even seriously soften at the temperature of the flame, and must be non-volatile, while during the conversion by the process of burning off the nitrate-laden cotton into the oxide skeleton, shrinkage must not be excessive.

These requirements are most nearly satisfied by the oxides tabulated below, and a glance at the recorded illuminating powers, as given by mantles made with the commercial salts and with carefully purified salts, shows the wonderful influence in the power of emitting light which traces of foreign oxides impart to the mantles.

When one comes to test the oxides in this table for shrinkage, duration, and strength, one finds that three only of them are fit to be employed as what one may term the basis of the mantle. These are zirconia, alumina, and thoria; but on making mantles with them, it is found that zirconia in the hottest part of the flame is liable to considerable and rapid shrinkage, while with alumina not only is there shrinkage and semi-fusion, but also slow volatilization, so that the

Light Emitted per Cubic Foot of Gas by Various Oxides.

Oxide.		Pure.	Commercial.
Metals—			
Zirconia		1.5	3.1
Thoria		0.5	6.0
Earth metals—			
Cerite earths...	Ceria	0.4	0.9
	Lanthana	..	6.0
Yttrite earths...	Yttria	..	3.2
	Erbia	0.6	1.7
Common earths.	Chromium oxide	0.4	0.4
	Alumina	0.6	0.6
Alkaline earth metals—			
Baryta		3.3	3.3
Strontia		5.2	5.5
Magnesia		5.0	5.0

life of the mantle is gradually shortened by the threads of oxide structure near the base of the mantle slowly wasting away. On the other hand, thoria practically occupies a position by itself as the ideal basis for the mantle, being readily shaped at the temperature of the blowpipe flame, and resisting the action of temperature in the atmospheric burner for a considerably longer period than any other known oxide, while in the conversion of a fabric saturated with thorium nitrate into thoria, the shrinkage is smaller than with any other substance.

The factor which gives it its pre-eminence as the basis of the mantle is that in the conversion of thorium nitrate into thorium oxide by heat, an enormous expansion takes place, the thorium oxide occupying more than ten times the volume of the nitrate taken. This, of course, means that the mass is highly spongy, and contains an enormous number of little air cells, which must render it a splendid non-conductor. As has already been stated, a mantle made with thoria alone gives practically no light, but the power of light-emissivity in it is awakened by the addition of a small trace of ceria, and careful experiment shows that as ceria is added to it, little by little the light which the mantle emits grows greater and greater, until the ratio of 99 per cent. thoria to 1 per cent. of ceria is reached, when the maximum illuminating effect is obtained, and that the further addition of ceria causes this to gradually become less, until when some 10 per cent. of ceria has been added the light given by the mantle is again almost inappreciable.

When cerium nitrate is converted by heat into cerium oxide the expansion which takes place is practically nil, the ceria obtained from a gramme of the nitrate occupying about the same space as the original nitrate. The result is that although by weight the ratio of ceria to thoria is as 1 to 99, by volume it is only as 1 to 999, and we have now to see the theories which have been put forward to explain the wonderful power of light-emissivity awakened by these excessively minute traces of the excitant.

Dr. Drossbach, early in the controversy, ascribed the power of the mantle to some special action of the ceria in converting heat rays into light, while Drs. Killing and Moschelles came to the conclusion that as ceria formed two oxides, the particles of ceria in the mantle, by rapid transition from one condition of oxidation to another, caused local spots of temperature due to more rapid oxidation at those points. Dr. Killing also favored the theory of catalytic action, afterward warmly supported by Dr. Bunte, while during the last few years Le Chatelier, Nernst and Bose, Thiele, Muthmann, Féry, White, Traver, Russell, and others have done an infinite amount of work upon the subject, while Drossbach, Killing, and Bunte have again attacked the subject from altered points of view.

The theory which always appealed most to me was the catalytic theory as enunciated by Dr. Bunte, and now that he has formally discarded it in favor of a theory of selective radiation, I feel more than ever

inclined to champion it, as it undoubtedly plays an important part in raising the temperature of the mantle.

I will not spend any time on the dual oxide of cerium theory, as, although it is the one favored by Baron Welsbach himself, I know of no satisfactory proofs that have been adduced in its favor, as apart from simple catalytic action, but I will devote myself to a consideration of the catalytic theory and the more modern work on temperature and radiation.

The general definition of catalytic action in the layman's mind is that it is a convenient word to cover a class of actions which the chemist is unable otherwise to explain, but the special form of catalysis with which I wish to deal is of a less obscure order. If we take a roll of platinum foil and heat it to redness over the gauze of a Bunsen burner, and then extinguish the flame and allow the current of mixed coal gas and air to flow over it before it has cooled to too low a temperature, it again commences to glow, and will remain incandescent as long as the flow of gas and air over its surface continues, this phenomenon being produced by the metal condensing hydrogen from the coal gas and oxygen from the air on its surface, and rendering them so chemically active that they combine on the surface of the metal below the ignition point of the mixture, and emit sufficient heat to render the foil red-hot. A catalytic action of this kind undoubtedly takes place with the Welsbach material. Dr. Bunte showed, some years ago, that ceria had the power of lowering the temperature at which hydrogen and oxygen combined, by about one-half—from 649 deg. C. (1,200 deg. F.) to 315.5 deg. C. (600 deg. F.), and one knows an action of this description is always intensified by increase of surface in the substance acting, so that in the platinum experiment, if spongy platinum instead of foil be used, it will ignite the gaseous mixture without previous heating, and the trace of finely divided ceria on the surface of the thoria in the mantle is so active, that, under proper conditions, the mantle can be kept luminous in a stream of coal gas and air. Dr. Luggin first showed this, and by a slight modification of his experiment it can be shown with beautiful clearness.

A mica chimney is fixed over the mouth of a large Bunsen burner, so as to form a prolongation of the tube, and the mixture of gas and air is lighted at the mouth of the chimney, the air supply being regulated to give a non-luminous flame. An ordinary Welsbach mantle is then hooked by its loop on to a stout platinum wire, and is held in the burning mixture of gas and air at the mouth of the chimney, where it glows and emits light in the usual way, and on now lowering it down through the flame into the mica chimney below, it continues to incandesce in the cold current of gas and air.

It is quite clear from this experiment that the catalytic vigor of the Welsbach mantle is sufficient to keep it incandescent in the mixture of gas and air, without the exterior heating of the flame, and it seems impossible, therefore, to ignore this action when the mantle is rendered incandescent under ordinary conditions. Before attempting to explain why this particular mixture of thoria and ceria, and no other, gives the highest possible illumination, it will be well to examine the other theories that have been brought forward.

If the Welsbach mixture were endowed with a special power of translating heat into light, proof of this ought easily to have been obtained by the way in which rare oxides and mixtures behave when heated out of contact with air. Dr. Bunte found that in trying this experiment there was a very small difference in the noticeable light radiation from bodies of such widely different light-emissivity as carbon, magnesia, thoria, or the mixtures used in the Welsbach mantle.

In order to prove this, Bunte took a thick walled tube of retort carbon, the walls of the middle portion of which were reduced to a thickness of 0.059 inch for a length of about four inches, and on passing a strong current of electricity through the retort carbon cylinder, the resistance of the thin walled portion caused it to be heated up to whiteness, the temperature attained being estimated by him to be over 1,999 deg. C. (3,360 deg. F.). The tube was prevented from burning away at this highly-heated point by being coated with magnesia, over which an outer wrapper of asbestos paper was pressed, and in the interior of this tube small square prisms of magnesia were placed, coated with the substances to be examined, each prism being compared side by side in the hottest portion of the tube. The conditions existing could be observed through a small sight-hole at the end of the carbon tube.

By using double prisms, one of which was coated with the substance to be tested, and the other with a standard substance of known composition, it was found that practically little or no difference existed between the various materials tested. This point was also confirmed by some very interesting experiments made by Mr. Swinton, in which he inclosed various mantle materials in a vacuum tube and submitted them to cathode rays, by which a very high temperature can be obtained, capable of raising finely divided carbon to incandescence, and fusing platinum into glass. Using mantles made up of small squares of ceria and thoria alone, and mixed in varying proportions, he found that, although the mixture of 99 per cent. thoria and 1 per cent. ceria in a vacuum heated up to incandescence more rapidly than pure thoria alone, and on stopping the discharge cooled down more rapidly, its incandescence was only very slightly greater than that of the thoria alone.

It is clear that either Bunte and Swinton were in error in their observed results, or else that the idea of the Welsbach mantle having any peculiar power of converting heat rays into light must be discarded, as otherwise the same differences would have been noted when the materials were heated out of contact with air, as is shown in the flame.

(To be continued.)

JAPAN AND MUSIC.

THE SUCCESSFUL MUSIC TEACHING OF AN AMERICAN, LUTHER WHITING MASON.

By EPHRAIM CUTTER, M.D., LL.D.

BORN in Maine, the cradle of many great men, Luther Whiting Mason died there, 1896, aged 76. He was an educator in America, Europe, and Asia, and was publicly said to be at the very head of musical pedagogy. He was a builder of foundations in the primary department. The clearness and simplicity of his methods worked well among his pupils, from the eminent music teachers of Germany—who said they would like "to sit at his feet as little children"—to the children of Japan, that in ten minutes' time he had singing just as in America.

The present war brings the Japanese to the most prominent position in the world, and hence these words are timely to show how this Oriental nation adopted Western music and had it sung in forty thousand schools, the number of such public institutions in the whole nation. No other nation ever did this!

The way it came about was by Mr. Mason (as he wished to be called) meeting on the streets of Boston two or three Japanese Harvard students whom he never saw before, and asking them about their Japanese music. They saw the simple earnestness and truthfulness on his face and trusted him, with the result that he invited them to go to his house and tell him about it. They came. They were interested so that he also gave them instruction that was easily and eagerly absorbed until they became proficient pupils. They were in communication with the Japanese government, and reported what they had done. I do not remember whether the result of Mr. Mason being invited to go to Japan came from the pupils or from their teacher, who longed to give the benefit of his pedagogy to all the world—but the invitation came, and arrangements were made for him to go. He was a musical supervisor in the Boston schools. His business was to teach the teachers how to teach music in his absence. Even teachers who had known nothing about music were able to teach it by his methods. One of Mr. Mason's friends, knowing of his going to Japan, thought that he should have a farewell reception before his departure on such a mission. So he started out with the idea of a few friends giving him a parting dinner at some hotel. But as the invitation to his friends was given out, the number increased so rapidly that it was decided to have a public farewell in some hall and to present him with a parchment testimonial, also a microscope, etc. All this was done. There was an audience of one thousand persons in the auditorium of the Girls' High School Building. Mayor Prince presided. Mr. C. C. Perkins, president of the Music Committee of the Boston School Board, received the testimonial from the mayor's hands and then gave it to Mr. Mason in a beautiful appreciative address. There were other addresses commendatory, and one by Prof. E. C. Morse, who had lived in Japan, and said that Mr. Mason would not accomplish anything, as he had tried Western music there and it did not work. His opinion was sincere and received with respect. Afterward it was found that he had tried to have a choral class. This was building on no foundations in distinction as to the work later done by Mr. Mason, i. e., laying down groundwork.

Mr. Mason found on his arrival that Japan wished to devote all its means to future war with China and had decided to dispense with his services; but when he showed the press reports, the beautifully engrossed parchment testimonial and the microscope of his farewell reception, the government changed its mind and told him to land. After landing, Mr. Mason, like our army in Cuba, went at once to work to the great surprise of the officials, who thought he would first rest at least two or three weeks. Surrounded by interpreters, he went to the nearest primary school, and displayed his music charts with instructions, and as said before, had the pupils singing in ten minutes, as like American pupils would have sung!

This instant and complete triumph wholly won the Japanese heart. He was welcomed by and associated with the imperial court. Every facility was given him to go on with his work, in many ways too numerous to mention here save the following: Girls' Nobles' High School established by the Empress. If memory serves right, in three months he gave a public concert with the students of said school. Such was the success, so testified by an educated American tourist present, that the Empress publicly called him to her before the audience and thanked him for what he had done! This was published in the press even in America, where the writer saw it, and soon after met some Japanese in Boston and asked them about it. They said it could not be so, as the Empress never did such a thing. They were right in their reason, but not in the fact, as it was the *first time* the Empress did so. As we look over this history, it seems a very wonderful thing that Mr. Mason was given a palace to live in; that he had free access to the homes of the nobility to teach them and tune their pianos; that twice or thrice a week he met with the imperial orchestra and a blind court poet; that when they met, the subject was the selecting the music of the Japanese repertoire for the public schools. Mr. Mason in his publications used music that had been popular for a century; hence he presented only standard authors' compositions. He would play, for example, a psalm tune, music from Mozart. If liked, he would play it again and again until all agreed. Then he would tell the story of Mozart as a composer, and sing the words of true Bible character. He would tell them what they meant. The interpreters would translate to the old blind poet, and at the next meeting the blind poet would bring a copy in Japanese poetry in the same, long or other meter, all ready to be sung. It would then be sung in Japanese, and if satisfactory, adopted. These meetings were kept up for months, until a large collection of Western music resulted, with Japanese verse to fit.

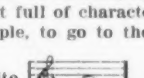
A souvenir Mr. Mason brought home was a flute that had been used many years, three hundred, I think, in said orchestra. It is said that the missionaries were almost aghast at the way Mr. Mason got in touch with the rulers of Japan and at the grand chance he had and improved to lay before them the gems of Christian and patriotic songs and tunes. The foundations he laid were good and strong. They abide and will abide.

In one of the nobles' homes he found a young lady who became very much attached to him, as to a father. She was taken ill, and Mr. Mason visited her. When it was found that she could not recover, she gave him as a keepsake her beautiful court dress with real gold lace. He brought it home, and showed it to the writer. He said the Japanese ladies were very timid, but when they put their trust in anyone, it was fully given. There was a charm about them that endeared them to their teachers. He found them, as may easily be inferred, very teachable and apt to learn.

The Japanese scale of music had five notes to our seven. Of course, it was impossible to adapt all our music to theirs. The matter kept coming up in the conferences with the court musicians and clashing, but Mr. Mason did not urge the change or press it, as it pressed itself, till finally the court musicians asked him to give the reasons why the western scale was better. He told them of the seven colors of the solar spectrum, and referred the physics of the scale to the professor of physics in the university, who demonstrated by the spectrum, tuning forks, sirens, and other acoustic instruments that seven steps in the scale were most natural. An imperial council was held on the subject, and the scale of Japanese music by imperial edict was changed from five to seven notes, and no more words about it! Mr. Mason restrung and altered Japanese musical instruments so that they could be used on the new musical scale. Besides, he organized a stringed and wind orchestra, with which he conducted concerts acceptably and successfully according to his own and others' testimony. I think he started them on making pianos and reed organs. In fine, he left hardly anything fundamental unattended to in his department to put the Japanese on the road to full development. Besides, he suggested improvements outside of his sphere. He advocated, for example, the cultivation of the wool industry.

While his work was so prosperous, he was called home. This was not to the minds of the Japanese, who wanted him to stay. On his departure, he was loaded with gifts; the Mikado decorated him and gave him a large web of gold and silk cloth from the famous loom whose products are placed in the silk museum at Lyons, France, as models. He was dismissed honorably, and after his return to America was in constant communication with Japanese officials, who trusted him implicitly. Hon. R. Kuki, the minister plenipotentiary and envoy extraordinary, accepted for his wife the hospitality of Mr. Mason's home.

Although modest and unassuming, Mr. Mason was one of nature's noblemen.

Music to him was an entity and a thing, as an apple or house or cat. To be sure, it was imponderable, spiritual, ideal, but full of character. He used by his system, for example, to go to the blackboard before the school and write . Then he would call up a pupil, and tell him or her to sound it in the concert pitch (of 432 vibrations to the second) and in nine cases out of ten the pupil would sound it correctly. Once he visited a school where one of his normal pupils was teaching, and who repeated the above example. The boy tried and stammered. His teacher did all he could to help him out of the maze, when Mr. Mason said, "Boy, do you see that note? It is just as much a thing as your ball. Call it a ball and hit it;" making a motion as if he was hitting a ball with a bat. Then the boy hit it all right at once!

It was, then, Mr. Mason's intense earnestness and ability of hitting the nail on the head, backed by the imperial power, that crowned his work in Japan with such a magnificent success that a nation of forty millions adopted his musical pedagogy throughout. Greater success he could not have had. Greater success no music pedagogue ever had.

After Mr. Mason's arrival home he was welcomed by a return reception dinner that filled the large dining hall of the New England Conservatory of Music, presided over by Mayor Palmer of Boston, and addressed by Joseph Cook, D.D., LL.D., and others, thus making a fit close to his eminently successful career in Japan.

Is it any wonder that Japan forges ahead in her modern march among the nations? Indeed, in music she has gone beyond America, where there are more than sixty musical pedagogies in public school use

besides the Mason system, and where, it is said, since Mason's day, the public-school music has devoluted somewhat.

Certainly Japanese music has not devoluted when it is now published in the Boston Transcript with high praise. We congratulate Japan that she had the common sense to adopt a system of music in her schools that received the highest indorsement of the highest musical critics in Germany and France, and laid the foundations strong and deep for future progress. Japan to-day has the best pedagogical museum in the world. Just so Japan stands first in the medical department of armies, giving very useful lessons to us in this country.

Never before did a meeting occur like that in Japan, when Buddhists, Shintosts, and Christians met, discussed and passed a resolution that the present war was for peace and the integrity of their empire, and in no sense a religious war. These utterances show a harmony of religions like that of the oratorios of Haydn in the music of the ear and like the exquisite concerts of the music of the eye that are found in polarized light! Judging from the national success of Mr. Mason's work in Japan, the Japanese deserve encouragement in their desire for peace and national integrity.

[Concluded from Supplement No. 1523, page 24399.]

LHASA AND CENTRAL TIBET.—III.*

By G. Ts. Tsybikoff.

We will now briefly describe the other prominent monasteries and cities we visited. They are Tashilhunpo, and the cities of Shigatsze, Gyantsze, Samyé, and Tsetang.

* Translated from the Isvestia of the Imperial Russian Geographical Society, St. Petersburg, vol. xxxix, 1903, part iii, pp. 187-218, for the Smithsonian Institution.

The monastery of Tashilhunpo is about 170 miles west of Lhasa, to the right of the river Brahmaputra, on the south side of a mountain peak that forms an arm between that river and its tributary, the Nyangchu, and was established in 1447 by a pupil of Tsongkapa, Ge-dun-dru, who is regarded as the first incarnation of the Dalai Lama. There are about 3,000 monks within this place, divided into three religious and one mystical faculties. The head of the monastery is the incarnation of "Panchen erdeni," who maintains the monks there. Five stone idols and gilt roofs in Chinese style constitute the ornaments of the monastery.

About two-thirds of a mile northeast of Tashilhunpo, upon a separate rock, stands the castle Shigatsze, at the foot of which grew up a city of the same name, with a population of scarcely above 6,000 or 7,000. Here are stationed small Chinese and native garrisons. The castle itself is well known from the fact that during the conquest of Tibet in the middle of the

THE OUTSKIRTS OF LHASA.

The orchards and trees in the outskirts of the city give the place a very beautiful appearance, especially in spring and summer, when the gilt roofs of the two principal temples glisten in the sun and the white walls of the many storied buildings shine among the green tops of the trees; but the delight of the distant view at once vanishes upon entering the city with its crooked and dirty streets.

ON THE ROAD WHICH CIRCLES LHASA.

The circular road along which the pious make their marches around Lhasa on foot or in prostrate bows is about 8 miles long. When these bows are faithfully performed the circle is completed in two days, making about 3,000 bows a day.

seventeenth century by the Mongol Gushi-khan it served as the residence of the governor of Tibet, Tszangbo, who, after a long resistance, was conquered and killed. The castle is now in a semi-deserted condition, and prisoners sentenced to die are thrown from its roof to the rock below.

About 50 miles from Shigatsze, in the valley of the Nyangchu, lies one of the old cities of Tibet, Gyantsze, which is a very convenient place on the commercial road to India from Lhasa and Shigatsze. From the religious standpoint it is famous for its great religious structure, Cho(d) den-gomang, five stories high, with many rooms and various objects of interest, especially ancient statues of Buddha. Commercially the city is known for the manufacture of rugs and cloths.

Up to the recent past the Tibetans made rugs of only one-colored wool in narrow strips, but now they weave, according to Chinese samples, continuous rugs with designs, which are much inferior in elegance to the Chinese, but in firmness much superior to them, as they are made of pure wool. We must assume that rug manufacture in Tibet could be considerably developed on account of the cheapness of labor and of sheep's wool.

The monastery of Samyé is on the left bank of the river Brahmaputra, about 65 miles southeast of Lhasa. It is the oldest of Tibetan monasteries, having been established at the beginning of the ninth century A. D. by the famous preacher of Buddhism in Tibet, Padma Sambava, and the Khan Tirsong-detszan. Its conspicuous feature is a five-story temple, a mixture of Tibetan and Indian architecture. The latter is evident by the fact that the top story is without columns, a feature so prominent in Tibetan style. This monastery, with its 300 monks, is maintained at the expense of the Dalai Lama treasury, and the idols are distinguished for their comparative cleanliness and care in the make-up.

About 20 miles east of Samyé, on the right bank of the river Brahmaputra, at the mouth of the fruit-producing valley Yarlung, lies the city of Tsetang (or Chetang), famed for the production of cloths, knitting, and the yellow monk hats. According to tradition, the first ruler of Tibet, Niatri-tszangbo, was found in the vicinity of this city and set upon the throne. The place occupies a favorable point on the road from Bhutan to Lhasa, as it enters the valley of the river Tszang. On the border of Bhutan lies the city of Tszona, where there is a market each spring that attracts many merchants from Lhasa.

Passing now to the government of Central Tibet, the dependence upon China is made evident by the Peking Court appointment of a Manchu resident to manage the higher government. At the head of the local self-government stands the Dalai Lama as the spiritual and secular head of Central Tibet.

The Dalai Lamas attained their spiritual importance at the time of the Lama Gedun-Gyamtso, the superior of the Brebung monastery, who lived from 1475 to 1542. He was the superior simultaneously of the two

WOMEN FROM THE COUNTRY ON THE WAY TO MARKET IN LHASA.

The Tibetans seem to be inclined to joviality, which manifests itself in song and dance during their frequent public holidays. Women enjoy perfect freedom and independence and take an active part in business affairs, often managing extensive enterprises unaided.

A FARMING SCENE IN TIBET.

Agriculture is the chief occupation of the settled population. Barley is the standard crop, from which the popular and harmless barley-wine is made; then comes wheat, for wheat flour; beans for oil, and peas, used by the poorer class in form of flour, or crushed for horses, mules, and asses. The field work is done principally by "dzo" (a cross breed of yak and ordinary cattle), yaks, and asses.

monasteries Brebung and Sera, and during his life acquired such fame that he began to be regarded as the incarnation of his countryman, the famous organizer of the monastery of Tashilhunpo, Gedun-dru. But the custom of finding incarnates in youths begins after his death, and one officer of the castle proclaimed his son as this prophet's incarnation. This is evidently the first instance of the proclamation of an incarnate, and when he succeeded to the rights of his predecessor it was his fortune, worshiped almost from the cradle, to be invited by the Mongol, Altan-Khan, who gave him the title "Vajra-dara dalai-lama," which was sanctioned by the "Ming" Emperor of China. The significance of the Dalai Lama in Tibet, however, was at first not very great, which explains the recognition of the son of a Mongol prince as the fourth incarnate, who, it is true, was killed in the twenty-eighth year of his life in Tibet. The Mongols claim that the Tibetans killed him out of race hatred, and that they even cut him open as the Mongols kill sheep. His successor, Ag-vang lo-sang-Gyamtso, now called simply "Na-va-chenbo"—that is, the Fifth, the great—succeeded in acquiring the secular power, which at first was still only nominal. This Dalai Lama, in combination with the first "banichen," did not hesitate to invite Mongol arms to his country in order to conquer the detestable secular governors. Although they succeeded in accomplishing it, Tibetan affairs began to be interfered with either by Mongol princes, or those recognizing the superiority of the Manchu dynasty, or those who struggled for independence. After the death of the fifth Dalai Lama, for a period of forty years, the Dalai Lamas became the pretense of political intrigue of various power lovers until a series of historical events destroyed the power in Tibet of the Mongol and native princes, and until finally in the year 1751 the Dalai Lama was accorded the dominating power in matters religious and secular. The election of the Dalai Lama, up to the year 1822, the year of the election of the tenth incarnate, was based upon the prophecies of the highest Lamas and decision of the prophets, which is equivalent to an election by influential persons. But when the tenth incarnate was elected the system of the Emperor Tsien-lung, the casting of the vote by means of the so-called "serbum," or "the golden urn," was first applied. In this system the names of three candidates, determined by the former arrangement, are written upon separate tickets and placed in the golden urn. This urn is set before the statue of Jovo-Sakyamuni, and services are held there by deputies from the monasteries, praying for a righteous election. It is then carried over to Potala, to the palace of the Dalai Lama, and there in front of a board upon which the Emperor's name is inscribed, in the presence of the highest authorities of Tibet and a deputation from the principal monasteries, the Manchu Amban, by means of two chopsticks, draws out one of the tickets. He whose name is written upon the ticket is placed upon the Dalai Lama throne. The election is confirmed by imperial decree, and the fortunate or unfortunate youngster is brought into the place with great honors. From this time on he is accorded appropriate honors and worshipers flock to him. In his youth he is taught reading and writing under the guidance of a special teacher—ioiu-tszini—selected from among the most learned famous Lamas. Then he is given a purely religious education, following the above-mentioned five sections with all their seven commentaries. For practical disputes one learned Lama is detailed from each of the theological faculties of the three principal monasteries. These instructors are called Tszang-skab-khanpo. Our Buriat countryman, Agvan Dorchzheyev, was one of these with the present Dalai Lama.

After finishing the course of instruction he receives the highest degree in theology in the same manner as the other Lamas, but, of course, with a more liberal distribution of money to the monasteries and more careful questions on the part of the learned Lamas who dispute with him and who are appointed in advance. After this, when 21 to 22 years old, the Dalai Lama enters the ripe and independent existence. Since 1806 five Dalai Lamas have reigned. The present incumbent, the thirteenth, Tubdan-Gyamtso, was born in 1876, so that now he is 27 years old. About six or seven years ago he had a struggle with his regent, most famous of Tibetan hutuktu, "Demo," and came out victor, which no doubt saved him from the fate of his four predecessors, who perished at various ages, frequently the result of violence inflicted by regents or representatives of other parties that were striving to remain longer close to the "power." The present Dalai Lama accused Demo of organizing plots against his life, confiscated his immense wealth, and placed him under a rigid home arrest in a separate room, where Demo was discovered suffocated one beautiful morning in the autumn of 1900. The Dalai Lama assumed the head rule of Tibet, and one of his conspicuous acts is the abolition of capital punishment, which was practised extensively by the regents. It seems in general that he is very energetic, and inclined to be a good man, with considerable love for knowledge.

The second person of the lamaist hierarchy is the Panchen-Erdeni, who lives in a monastery in the province of Tashilhunpo Tsang. The first Panchen-Erdeni was the Lama Lobzang Choigyi-Gyaltsan, who was born in 1570. This earnest Lama was the instructor of the fourth and fifth Dalai Lamas, when he played an important rôle in political affairs, which served to enhance the power of the Dalai Lama. The official title, Panchen-Erdeni, and the imperial diploma and seal was granted only the third Panchen, Pandeyéshé, in 1870 at an audience at Peking. At present the sixth incarnate lives; he was born in 1882, and is therefore 20 years old.

The Panchen is next to the Dalai Lama in official capacity, but in the supervision of the lamaists he is considerably above him, because of his holiness. Especially is he regarded as the future king of the holy world "Shambala," in which he will be the principal leader.

It is customary to call the Dalai Lama also "Chyabgong thamchäd-mkhen-pa" (the omniscient—the object of faith), but the Tibetan applies this name to every eminent Lama incarnate he respects, since the charm of the Dalai Lama, as a holy individual, is less effective upon the religious feeling, simply because of his distance, than that of a Lama more easily approached, to whom he can appeal more often with inquries relative to his religious requirements. The Dalai Lama, therefore, is known at places distant from Lhasa only as the principal ruler of Tibet, while the religious sentiment of the laymen is directed toward their patron, regardless of the sect to which he belongs.

The teachings of Tsongkapa now reign supreme in Central Tibet, but after the struggle during the first period of their introduction they are now entirely reconciled and to a certain extent are indifferent toward other sects. The contemporary lamaist in general and the Tibetan in particular regard the objects of faith of the various sects with exactly the same reverence. Even the central government of Tibet, with the Dalai Lama at its head, frequently bows before the representatives of the old red-hat sect (the yellow-hat sect predominates now). The laity does this, of course, out of ignorance and superstition, but such explanation does not apply to the higher representatives of the yellow-hats, who are guided by Tsongkapa's way of looking at the world and possess a knowledge of the difference in the views of other sects. We believe that the conduct of these men toward other sects is inspired by political motives, the desire to satisfy the superstitious requirements of the populace, and to be vindicated in case of popular suffering and unfortunate political events.

The central government of the land is in the hands of a council presided over by the Dalai Lama, called "deva-dzung." The principals in this council are four "kalons," or dignitaries, appointed by the Chinese Emperor, and their meetings are held in a special office—"kashag," or executive house. They are appointed from prominent aristocratic families, three of them civilians, the fourth a clergyman. For the local administration governors are sent from the "deva-dzung," usually two in number with equal powers—one a clergyman, the other a civilian. Districts are frequently leased, the lessee ruling according to established custom, being obliged to pay into the treasury a certain sum of money or to pay in kind. Usually these lessees are members of the higher administration, and they send their own representatives into the districts.

Of late the central government has apparently begun to strive to accumulate land, for which purpose it takes away strips of land from the monasteries under various pretenses or makes purchases on installment from the annual income.

The affairs of Tibet in general are ruled by the hereditary aristocracy, whether it be the son who inherits his father's rights or the incarnate who inherits the rights of his predecessor. As the born aristocracy lives in strict isolation, not mingling with the common people, the central government, despite its deliberative character, may be called an aristocratic oligarchy.

We stated that the Dalai Lama is the head of the central government. The question arises, Who takes his place in the interim between his death and the election of a new incarnate and until the latter becomes eligible? This question arose for the first time in 1757, after the death of the seventh Dalai Lama, and was solved by the appointment of a regent by the Chinese Emperor under the official name "the director of the Dalai Lama's treasury," with the title "nomunkhan." In writing, the Tibetans refer to him as "the Khan's viceroy," and in their daily conversation simply "the Tibetan khan." The first man appointed to the regency was the very eminent hutuktu "Demo," after whom other hutuktu were appointed.

The tribunal and, in general, all administrative affairs are based on bribery, court examinations, on torture by means of lashes and similar methods, cauterization by means of burning sealing wax being regarded as the most severe. The punishments are execution by drowning, imprisonment, banishment with giving away into slavery, blinding, amputation of the fingers, lifelong fetters and foot stock, and lashes.

The permanent army, maintained by the treasury, consists of 4,000 men. Its armament consists of spears, matchlock guns, and bows. For the protection of the body they have a helmet ornamented with feathers, a small plaited shield, and some wear armor. They are officered by "daipons," appointed from the higher aristocracy. The soldiers usually live in their homes in the villages and only periodically gather at posts, where they are inspected and taught to fire blank charges, and the use of the bows. The army is divided into cavalry and infantry. Despite the tendency of the Tibetans in the eastern provinces to indulge in pillage and highway robbery, the central Tibetan dislikes to make war; he is much more peace loving and more inclined toward peaceful labors, on account of which he regards military duty as superfluous and interfering with domestic pursuits. One frequently sees soldiers on the way from an inspection spin wool, stitch shoes, turn a prayer wheel, or repeat their chaplet.

Speaking about the East Tibetan robber tribes, we must say they try to prey upon the goods of others without bloodshed, threatening only the cowards. As soon as they see that the intended victims are determined to show serious resistance, they escape to their quarters. If one band of robbers strips a victim of everything, another band will clothe him and supply him with food.

The monasteries are governed by their own laws, administered by their own elders, the highest of which in the principal monasteries are appointed by the Dalai Lama. Discipline and the whole *régime* is based on "the fear of the governors." This fear must be manifested even on the street; a monk must not show himself before them on the street. When, on very exceptional occasions, he does meet them, he must lie down, wrap his head in his hood, and lie motionless as if dead. Justice is also based principally on bribery, and the punishment is banishment from the monastery with a fine of money and lashes. The material condition of plain monks in Tibet is so bad that the convicted always prefers the punishment of the lash to fines.

The foreign relations of Tibet are conducted with British India through Bhutan; with Kashmir through Ladak, and directly with Nepal, China, and Mongolia.

Tibet imports from India English materials, principally cheap cloths, enameled vessels, teapots, plates, and cups; objects of luxury, as coral, amber, brocade; medicine and dye stuffs; and various English trinkets, such as mirrors, beads, jars, matches, penknives, etc. All these articles are imported by native Bhutanese, Nepalese, Kashmiri, and Chinese merchants. In general, the Tibetans are of late becoming more and more fond of English products; the English rupees, too, are beginning to compete with the local coinage. The things exported to India are yak tails, sheep's wool, borax, salt, silver and gold, yaks to a certain extent and horses and mules brought over from northern China.

From China the Tibetans import tea, which they love so well, chinaware, cotton and silk fabrics. From northern China, mules and horses are imported, and, to a limited extent, breeding asses.

For use by the Chinese, Tibet exports little, and the considerable amount of native manufactured articles, together with those imported from India, that are exported there go to satisfy the demands of the Mongol lamaists.

The articles exported are various objects of cult, as small statues, painted images, religious books, and prints made from carved wooden blocks, incense candles, ribbons, peacock feathers, leaf-shaped seeds "tsampaka," and similar articles that bring high prices only because of the piety of the Mongol lamaist and his reverence for holy things from Tibet. The more famous the person that produces these articles the more eagerly they are purchased and the higher is the price paid. But Tibet also has a trade in cloths, in knit goods, and in the yellow hats of the ecclesiastics, and this class of traffic, which depends upon the religious sentiment of the purchasers, as is the case with presents to Tibetan lamas, attains a considerable sum annually. The commerce in ordinary merchandise, however, scarcely exceeds $60,000.

Since objects of cult are exported to Mongolia and since only the treasuries of incarnates and monasteries possess capital, the commercial caravans are fitted out exclusively by the treasuries of the Dalai Lama or other rich incarnates and by monastery communities. The responsible officers of the caravans are called "tsonpons." The "tsonpons" sent out by the Dalai Lama must double the original capital in three years' time, which capital is estimated at a very inflated appraisal of the goods. Each succeeding "tsonpon" is the auditor of his predecessor—that is, he sees that the contract is fulfilled.

Here and there the merchants in Mongolia, besides their commercial operations, make collections of contributions for one or another enterprise of a monastery or an incarnate. If we add to this those immense sums that are being collected by famous and infamous lamas, whether they be invited to Mongolia or are there of their own accord, we can safely say that Mongolia to a considerable degree enriches Tibet.

Up to a very recent period there were no relations between Tibet and Russia, although Buriats, who are Russian subjects, have for a long time made secret pilgrimages to Tibet, fearing oppression from the Russian administration, and entered Tibet under the assumed name of "Khalkhas" Mongols, fearing exclusion as foreigners. About fifteen years ago "Khalkhas" and Buriats belonging to one community in Brebung quarreled for some reason, and the former called the latter "Oros," or Russians. The matter reached the highest authorities, and, thanks to the able management of the affair by the Buriat lamas, it was established that, although the Buriats are Russian subjects they are followers of the yellow-hat religion. The Khalkhas who raised the matter, having lost the trial, was obliged to leave the monastery, and the others received warning that they would be fined 5 lans (about $4) every time they call the Buriats "Oros." Russia can hardly hope to obtain a profitable market for her goods in Tibet, but it will pay her to establish relations with Tibet because it is the center of lamaism, to which are chained the thoughts of contemporary Mongols, of whom there are about half a million, under the names of Buriats and Kalmuks, who are Russian subjects.

THE GOOD OLD TIMES.

If it be true that "the proper study of mankind is man," we should all be ardent students of human nature, and as a matter of fact most of us are; for although comparatively few trouble themselves about the philosophy of life, the majority delight in the daily newspaper, the play, or the novel; and each one of these is but a review of the doings of men and women, and a chronicle of the manner in which their lives are molded by their environment. And the most trustworthy authority of all is the newspaper; for it is not the production of one mind, tinctured by what is known as the personal equation, but is made up of the thoughts of many. It affords, moreover, a picture of real life; and just as a child will always prefer a true story to one which is "make-believe," so we turn to the daily journal as a necessity, leaving other reading for what leisure we have to spare.

Although newspapers of a kind were published in this country as early as the seventeenth century, there are only two or three journals now in existence which are more than a century old, and one of these is the Times, which owns the proud position of being the leading organ of intelligence. And it is a matter of absorbing interest to turn for a moment from the bustle of life, as we know it to-day, and look back at some of the early issues of this paper in order to view the "fleeting show" which the world afforded one hundred years ago. The proprietors of the Times have recognized this natural craving of the present to peep into the past, and since the dawn of the twentieth century they have published daily short extracts from their columns of the same day one hundred years ago. These extracts are replete with interest, and many of them are as amusing as if they had been culled from the pages of a novel. We propose to select a few which have recently appeared.

It is abundantly evident that the Times in its infancy was far from being the sedate newspaper as we know it to-day. Some of the excerpts are of a frivolous nature; and occasionally the editor descends to the puerility of a pun! Sometimes, too, it waxes wroth as well as sarcastic at the expense of a contemporary. Thus, alluding to the True Briton, it says: "Will it be credited that this official demi-official Ideot (*sic*) could add anything to his daily portion of absurdity?" and accuses the same journal of attempting to undermine the Ministry, "by whom it has the baseness to affect to be employed or demi-employed. We shall not rake this dunghill." On another occasion it quarrels with two morning papers on the ground that they "tell their readers that a number of *dexterous* skaters crowded the ice on the Serpentine river the preceding day. This reminds us," it continues, "of an Hibernian dancing-master who boasted his professional agility by saying he was very *handy* with his *feet*." And we find that we must also take the Times of 1803 to task for its want of politeness to the fair sex, for we find it publishing the following piece of rudeness: "We have not heard that the unlucky Foreigner who teaches ladies to speak in their own houses has found a single scholar. Had the man taught them to hold their tongues he would have been employed by half the husbands in London, and adored by the servants!" In another extract we find that the ladies are rebuked for the way in which they follow the dictates of fashion in the matter of dress: "It is certain that some of our traveling nudes of fashion intended to conquer the Conqueror of the Continent. What glory would it have brought to this country if it could have boasted of giving a wife to the First Consul? How pretty would sound Lady G—— (we mean Lady Godiva) Bonaparte!" Sarcasm at the expense of fashionable frivolity in another entry takes anecdotal form: "A young lady who puts on a great deal too much *rouge* with too little care and art was lately boasting that she owed what little color she had to her custom of washing her face in cold water; but perceiving some little hesitation or astonishment in the company, she said to a gentleman, 'You don't seem to believe me.' 'Oh, madam!' said he, 'I have not the least doubt; it is very clear your ladyship always washes in the Red Sea.'"

There are many allusions to Bonaparte in these cuttings from 1803, for in that year, it will be remembered, France declared war against us; but space forbids us to enter here upon matters of mere history. We cannot, however, resist the temptation to quote the following: "Many people imagine that there is something peculiarly menacing and hostile to our coasts in Bonaparte's project for teaching his armies to swim; but we will venture our credit that his army will never get more than *half-seas over*."

Although war was actually declared in May of that year, it evidently came as a surprise to many, for two months earlier we find that "all the passengers who have come over in the late packets from France affirm that not the least suspicion prevailed in the public mind at Paris that there was any probability of a rupture between the two countries." But under the same date we note that "two hundred Pensioners from Greenwich Hospital are gone to Chatham and Sheerness to assist in rigging such ships as are ordered into commission." The idea of enlisting the services of Greenwich pensioners in preparing battleships for active service would nowadays be thought very quaint if introduced as an episode in a comic opera. Another extract shows that the authorities by no means considered the inmates of Greenwich Hospital as being unfit for further service: "It is in contemplation to call in the out-pensioners of Greenwich Hospital, in order that such as are able may do duty on board of guard-ships lying at the different ports, and also to expedite the fitting out of ships as may be short of their complement." One more entry referring to naval matters is of interest: "Thursday, Apl. 28 [1803].—The 'Victory,' of 100 guns, will take her guns on board this day, and will be ready for sea on Saturday next."

Here is an extract which shows that the smart society journal was not altogether unknown in the early days of last century: "One of the dashing papers of last week gives the important intelligence that a certain family has *changed its cook*, and that a Taylor has made alterations in his House! This information is called *fashionable*—but God help us if it is!" Some of the extracts dealing with the social and domestic manners of the time are of great interest, and it is impossible not to feel that we have advanced somewhat in the matter of politeness. One cannot imagine such a scene in these days as that described in the Times of 18th April, 1803: "There was a shameful disturbance at the Opera House on Saturday night, in the middle of the first act of the ballet, owing to an attempt of a person in the dress of a gentleman to cross a scene in full view of the audience. One of the servants of the theater, endeavouring to prevent him, was knocked down; but, immediately recovering, a ring was called for, and, both being joined by friends, a battle actually took place on the stage." Is there a novelist so bold as to introduce an episode like this into his pages? And if he did so, would not the critics blame him for inventing such a preposterous situation? But truth was ever stranger than fiction. A few months before this strange pitched battle on the Opera House stage, we find an entry referring to "that abominable nuisance Bartholomew Fair:" "Among other novelties introduced at the fair was a number of balloons, as if the shew itself were not sufficient to turn the heads of the people and cause dissipation without this addition to the other entertainments." Bartholomew Fair, Smithfield, was originally instituted for the legitimate purposes of trade; but it gradually assumed the character of a rowdy and profligate assembly, and was abolished.

We may also congratulate ourselves upon the purity of our civil service as compared with that of a century ago. The following advertisement, which appeared in October, 1802, shows that the sale of public appointments was not unknown: "Place in a Public Office.—Any gentleman who can procure an appointment to a situation in any public office of which the income will not be less than three hundred pounds per annum, and if of considerably higher value it would be much preferred, may meet a gentleman who will be glad to purchase the same, by addressing to C. Warner, Esq., to be left at No. 77 High Holborn."

There are many references to election matters and the rough-and-ready methods practised by the various candidates for parliamentary honors. Thus we read of a curious episode which occurred at a contested election in Huntingdonshire: "Sir Robert Bernard had kept back a reserve of votes for the last day of the poll, who were to come in from a particular part of the county; but Lord Sandwich, who had opposed his son to him, opened a booth on the road by which they were to come in, under the colors of Sir Robert. Here he had placed several of his friends, who insisted upon the electors coming in and drinking success to their favorite candidate, a challenge which was willingly accepted. Here they were so well plied with wine and punch, with an infusion of laudanum, that they were soon put to rest; and the noble lord actually had them laid out on straw in piles by the side of the road, where they waked at last; but the booth had disappeared, with the host and all his merry companions."

After an election at Norwich one of the electors happened to meet Mr. Windham, who had contested the seat, and the man took the opportunity of stating in a very offensive manner why he had voted against him. "Mr. Windham replied very coolly, 'You do this, sir, to put me off my guard, but I am collected; and though the laws of courtesy bid me knock you down, yet, as you have before voted for me, and as I think it will teach you how to behave in future, I shall only pull your nose'—which he did by *wringing it well*."

The advertisements are not the least entertaining and interesting portion of these early issues of the Times, and they tell, among other things, how small was London as compared with what it is to-day. Houses are advertised for sale, and described as desirable residences only a mile or two from town, with so many acres of meadow-land, fruit-orchards, etc.; and we sigh as we remember that on that site now stands an unsanitary slum, crowded with human beings, and without a fruit-tree within five miles of its dirty surroundings. Among the advertisements we, of course, find that of the plausible quack, who was as artful in baiting his hook as he is to-day. Witness the following: "Those who wish to know that our great Creator is merciful as He is omnipotent, and that He never intended to torture mankind with disorders of extreme pain without putting it in their power to relieve themselves, are requested to attend at Copenhagen House on Monday next, at 2 o'clock, where a game of fives will be played by 10 men, all of whom have been cured by the Guestonian medicines after they had been returned from the London hospitals as being incurable. The attendance of any medical gentlemen belonging to these said hospitals will be esteemed a favour conferred on their most obedient servant, B. Guest," etc.

There are few references to art matters; but one there is of curious interest, reflecting as it does upon the *bona-fides* of the then president of the Royal Academy, Mr. Benjamin West. There is a well-understood law that no picture which has been previously exhibited is to be sent in to the Academy. The president that year (1803) sent in a picture representing Hagar and Ishmael in the Wilderness, and one of the members of the council challenged its admission on the ground that it had been hung at a previous exhibition. The artist had written his name in the corner of the work, as is customary, with the date 1803, and on the faith of this inscription it was determined to hang the picture. But the doubting one examined that date more minutely, and discovered another beneath it imperfectly obliterated, showing the figures 1776. Here was a pretty kettle of fish! Back catalogues were consulted, and it became plain without the shadow of a doubt that "Hagar and Ishmael" had made its public appearance at the Academy exhibition of twenty-seven years before. We read that "the members of the council, indignant at the deception, regarded each other for some time in silent astonishment. At length it was resolved that the secretary should write to the president requesting him to withdraw the performance." In the catalogue of the National Gallery of British Art, at South Kensington, appears the following entry among the pictures credited to Benjamin West, P.R.A. (*b.* 1738, *d.* 1820): "Hagar and Ishmael. Signed (1776). Chalk. *Bought*." This, presumably, is the picture above referred to.

What wonder is it that there is little mention of scientific matters or of inventions in these early pages of the Times? The steam-engine was as yet in its swaddling-clothes. Electricity was something of a magical nature which had no common interest, for it had not yet been applied to the service of man, although Galvani and Volta had made their names known. Most people were stay-at-homes, for means of traveling existed only to a very moderate extent: the railways had yet to come. Then, as now, such scientific advances as were made were wrongly described and grossly exaggerated. Let us take, for example, the following: "Dr. Galvani has discovered a principle by which motion can be restored to dead bodies; and *Citizen Potel* of Paris has discovered a mode of employing *oxygenated muriatic acid gas for* the actual resuscitation of the dead. If thus death and disease are subject to the powers of human invention, what miracles are we not still to expect from the *age of wonders*." We also read of "M. Garnerin's flight into the aerial regions," by which, of course, is meant a balloon ascent, and of the trial of an invention "to enable persons to dive to a considerable depth, and fasten tackle to ships which may be sunk in order to hoist them." Another reference to a flying-machine is evidently intended to be sarcastic: "Mr. Barrett, it is said, intends converting his balloon into a diving-machine, which has been suggested by its antipathy to mounting. The best Philosophers are of opinion it will dive with great alacrity, particularly if he attaches his cradle." We are also informed that a Swedish captain "has invented a machine for swimming and floating on the water without danger of drowning. As a reward for this discovery his Swedish Majesty has granted him a sum of 2,000 rix-dollars."

It is interesting to note that antiquarian research was not unknown at the beginning of the nineteenth century, for we read that "the Pope has ordered a hundred galley-slaves to be employed in digging for antiquities in the old city of Ostia."

But naturally the greater interest is found in paragraphs which refer to our own country. It is indeed difficult to realize the conditions of life when railways were unknown, and when before a journey by coach was contemplated, say, from Edinburgh to London, the prudent man made his will. For it was not alone accident by road that he risked. "The different roads about town," we are told in one entry, "are much infested by Highwaymen. Thursday night a gentleman took a post-chaise from town to Edgware; and before he had proceeded more than four miles he was told by several persons that they had been robbed, and advised to return if he meant to avoid their fate." There were no police; the streets were lighted with feeble lamps which went out if a high wind was blowing. Footpads lurked under the shadow of St. Paul's. The jails were full, and executions for minor offenses, as well as for murder, were terribly frequent; every man carried a cudgel to defend himself against possible assault; and, taking one thing with another, "the good old times" were hardly so good as the present. We have lifted the curtain upon scenes which appear to us, in these days of orderly government, of rapid transit, rapid means of communication by telephone and telegraph, and general comforts of life, to belong to another planet rather than to our own. And we can only wonder whether, when another century has elapsed, our posterity will look back to the early days of the twentieth century with the same feelings of curiosity and amazement as those with which we regard the doings of the past.—Chambers's Journal.

Secondary Radium Rays.—A. S. Eve has investigated the secondary rays produced by the β and γ rays of radium for the purpose of comparing the results with those obtained by Townsend in the case of secondary Röntgen rays. He finds that the secondary radiation from various substances follows approximately the same order as their densities. The coefficients of absorption of secondary radiation by various substances also follow roughly that order. Good radia-

tors are therefore good absorbers. Neither the secondary radiations nor the coefficients of absorption are proportional to the densities. The secondary radiation does not come from the surface merely, but from a total depth varying from about 1.5 millimeters in the case of lead to about 3 millimeters for glass, aluminium, or paper. It is mainly independent of the state of the surface. Almost the same amount of radiation is obtained from solid iron as from iron filings; from liquid and from solid paraffin; from ice and water; from paper, millboard, papier-maché, mahogany, pine, and basswood. The theory which agrees most nearly with the results is that the secondary radiation set up in a thin layer is proportional to the density and to the rate of absorption of the primary rays.—A. S. Eve, Philosophical Magazine, December, 1904.

EPICYCLIC TRAINS.*

By THORNTON KNOWLES.

IN most cases where toothed gearing is employed, the wheels in gear with each other rotate, while the frame supporting them remains stationary. If, instead of the frame being fixed, one of the wheels constitutes the fixed link, the frame being permitted to revolve round the axis of the fixed wheel, we obtain an epicyclic train. Such a train is capable of producing a high

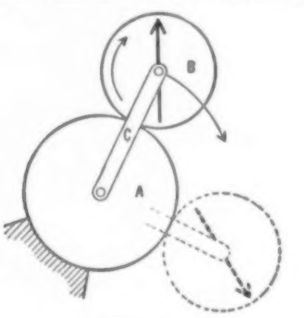


FIG. 1.

velocity ratio with the employment of a very few parts.

The simplest case is that shown in Fig. 1, in which two wheels *A*, *B* are in gear and connected by a link *C*. If the wheel *A* be fixed and the link *C* rotates, the motion of the wheel *B* will be the resultant of two components—that of its own motion relative to the link *C*, and that of the motion of the link *C* relative to the fixed wheel *A*. In any case where two bodies have motion relatively to a third which is fixed, the angular movement of the first to the third is the algebraic sum of the relative angular movements of the first to the second and the second to the third. The angular movement of the wheel *B* with regard to the wheel *A* is, therefore, the algebraic sum of the angular movements of the wheel *B* relative to the link *C*, and of the link *C* to the wheel *A*. If *N* be the velocity ratio of the two wheels, for one revolution of the arm *C* in a clockwise or positive direction the wheel *B* will have moved $+ N$ revolutions relative to the arm, and the arm will have moved $+ 1$ revolution with regard to the fixed wheel *A*, making

$$B\text{'s revolutions} = 1 + N.$$

To make this clearer, suppose the wheels *A* and *B* to

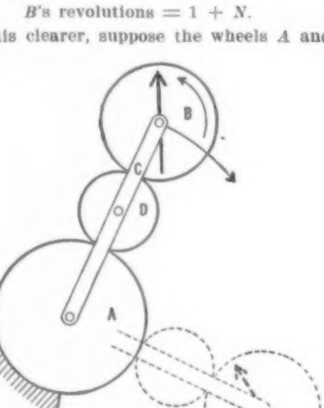


FIG. 2.

have 80 and 60 teeth respectively; then, if *C* were fixed, for every revolution of the wheel *A* in a negative direction the wheel *B* would make 1 1-3 revolutions in a positive direction. Now, if while the wheel *A* is making a single revolution in a negative direction, the whole of the mechanism be rotated one revolution in a positive direction, the wheel *A* will be stationary, and the wheel *B* will make 1 1-3 + 1 = 2 1-3 revolutions.

If an idle wheel *D* (Fig. 2) had been interposed, the direction of rotation of the wheel *B* would have been negative, and therefore, with other conditions the same as before, the wheel *B* would make — 1 1-3 + 1 = — 1-3 revolution. From this it will be seen that if the wheels *A* and *B* were equal in diameter the wheel *B* would not rotate.

In Fig. 3 is shown what is known as a compound epicyclic reverted train, in which the wheel *A* is still fixed, and the wheel *B* is mounted loosely on the same shaft as the wheel *A*, from which it is driven by the wheels *D*, *E*, which are both keyed on one axle. Suppose the wheels *A* and *B* to have 80 and 60 teeth respectively, as before, while the wheels *D* and *E* have respectively 50 and 70 teeth, the revolutions of the

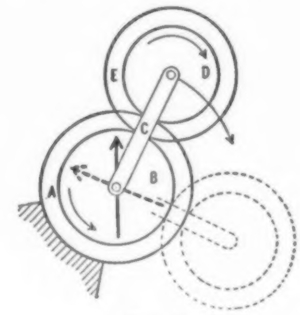


FIG. 3.

wheel *B* for one positive revolution of the link *C* would be

$$-\left(\tfrac{80}{50} \times \tfrac{70}{60}\right) + 1 = -\tfrac{28}{15} + 1 = -\tfrac{13}{15} \text{ revolution.}$$

It will be evident that, by making the difference in the diameters of the wheels small, such a train will give the wheel *B* a very small rotary motion indeed for each revolution of the link *C*.

Fig. 4 shows an example of an epicyclic reverted train in which the wheel *A* is annular. In this form an extra wheel *D'* is usually placed opposite the intermediate wheel *D*, to act as a support. This case is similar to that shown in Fig. 2, except that the revolutions of the wheel *B* are positive. Suppose that the wheel *A* has 56 teeth and the wheel *B* 32 teeth; the wheel *D* will consequently have 12 teeth, since it is to gear with both the wheels *A* and *B*. The revolutions of the wheel *B* for one revolution of the link *C* will be

$$1 + \tfrac{56}{32} = 2\ 3\text{-}4.$$

The arrangement shown in Fig. 5 is the same as that shown in Fig. 1, except that the wheel *A* is of the annular type, and the revolutions of the wheel *B* rela-

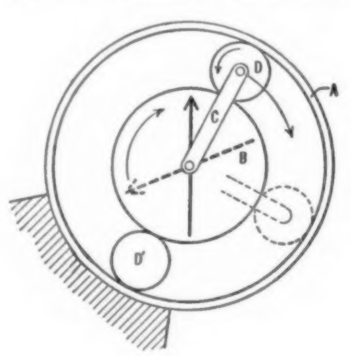


FIG. 4.

tive to the link *C* are negative. With the same number of teeth as in the example worked out with reference to Fig. 1, the revolutions of the wheel *B* would be

$$-\tfrac{80}{60} + 1 = -1\text{-}3.$$

In practice, however, it is usual to prevent the wheel *B* from rotating on its axis, and to allow the wheel *A* to rotate. If this were so in the above example, the wheel *A* would make

$$+\left(1\text{-}3 \times \tfrac{60}{80}\right) = 1\text{-}4 \text{ revolution}$$

during one revolution of the arm *C*.

The applications of epicyclic gearing in modern machinery are extremely numerous and varied, many of them exhibiting great ingenuity. The advent of the motor car and the development of bicycles and tricycles have done more to increase the sphere of application of such gearing than any other branch of engineering.

One of the best-known cases of an epicyclic train at the present day is probably the driving gear of the "Bantam" bicycle. This arrangement is also often called the "Crypto" gear. In Fig. 6 is shown a section through the hub of the front wheel of a "Bantam" bicycle. To the frame *H* is fixed an annular wheel *A*, concentric with the axle *G*, to which the pedals *F* are secured. A wheel *B* is formed in one

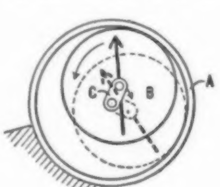


FIG. 5.

with the hub of the bicycle wheel, and is driven by means of the planet wheels *D* mounted on the disk *C* which rotates with the cranks *F*. To better comprehend the arrangement of the wheels, it will be well to refer back to Fig. 4, which is a diagrammatic end view of the gearing. Taking Figs. 4 and 6 together, it will be seen that the hub *B* rotates in the same direction as, but at a greater angular velocity than, the cranks *F*. Thus it is obvious that this arrangement gives a higher gear than by driving direct without the intervention of the toothed wheels. With driving gear of the proportions of the example worked out in connection with Fig. 4, an ordinary 24-inch wheel would be geared up to 66.

In Fig. 7 is shown a form of epicyclic gearing of wide application, known as Starley's balance or differential gear. The object of this arrangement is to enable the wheels of the driving axle of a motor car or tricycle to have a motion relative to each other when turning a corner. The axle is divided into two parts *L M*, provided with bevel-wheels *A* and *B*. These are driven by means of the chain wheel *F*, in which are mounted bevel wheels *C D* in gear with the wheels *A B*, the wheels *C D* being free to rotate on the spindles *E*. When the motor car or tricycle is running in a straight line, the two parts *L M* of the axle rotate at the same rate, and the wheels *A*, *B*, *C*, *D* remain in the same relative position to each other. When going round a curve, however, the two parts *L*, *M* of the axle will be rotating at different rates. This will cause

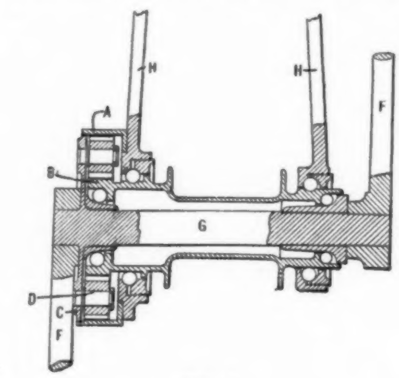


FIG. 6.

the wheels *A B* to have a relative motion, thus turning the wheels *C D* on their axes. This rotation of the wheels *C D* does not in any way influence the driving effort of the chain wheel *F*. Practically all present-day motor cars are fitted with differential gear of this or a similar type on their driving axles.

In some forms of bicycles, a bevel-gear similar to the above is fitted in the bottom bracket, and the two wheels *C D* are driven from the pedal cranks direct. The wheel *A* is fixed to the frame, and the wheel *B* is free to rotate on the crank axle. Mounted on the wheel *B* is the large chain wheel for driving the back wheel. This form of the gear gives the wheel *B* two complete revolutions for each revolution of the pedals, thus obviating the necessity for any very great difference in the diameters of the two chain wheels, and also affording an easy method of increasing the gear.

The practical application of the type of epicyclic train shown diagrammatically in Fig. 5 is represented in Fig. 8 as applied to the driving mechanism of a steam winch or capstan. In this, as in most applications of the same type, the annular wheel *A* rotates while the wheel *B* is prevented from rotating on its axis. The wheel *B* is mounted on an eccentric *H*, which is turned solid with the shaft *F*, and which has an eccentricity equal to half the difference in the diameters of the pitch circles of the wheels *A* and *B*.

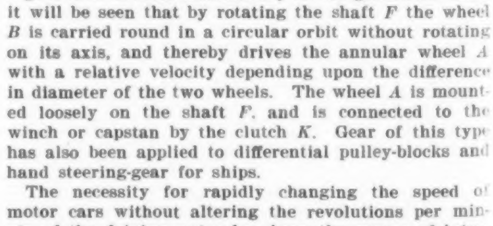


FIG. 7.

To prevent the wheel *B* from rotating, lugs *G* are formed on one side, which slide in vertical grooves in a circular disk *D*, which itself is fitted with similar lugs *L* free to slide horizontally in the groove *E*. Thus it will be seen that by rotating the shaft *F* the wheel *B* is carried round in a circular orbit without rotating on its axis, and thereby drives the annular wheel *A* with a relative velocity depending upon the difference in diameter of the two wheels. The wheel *A* is mounted loosely on the shaft *F*, and is connected to the winch or capstan by the clutch *K*. Gear of this type has also been applied to differential pulley-blocks and hand steering-gear for ships.

The necessity for rapidly changing the speed of motor cars without altering the revolutions per minute of the driving-motor has been the means of introducing several change-speed mechanisms, many of which have an epicyclic train as one of their constituent parts. The great advantage of such gearing for this purpose is that two speeds, at least, are always possible, since one speed is obtained by the gear running as an epicyclic gear, and another is obtained by locking the wheel train so that it turns as a whole.

The change-speed mechanism shown in Fig. 9, and known as Beaumont's change-speed gear, affords a good example of those gears, which possess, as an important feature, one or more epicyclic trains. This gear may

* Technics.

be mounted on an intermediate driving shaft, or on the main driving axle A of the car. It comprises three pulleys L, M, N, mounted loosely on the shaft A. Between these pulleys, and keyed to the shaft A, are toothed wheels B, C. Adjacent to these wheels are toothed wheels D, E, secured by keys to the bosses of the pulleys L, N respectively. Upon a spindle F, carried by the central pulley M, are mounted four toothed wheels G, H, J, K, in gear with the wheels D, B, C, E respectively. The wheels G, H rotate together, and form, with the wheels D, B a compound epicyclic reverted train, similar to that shown diagrammatically in Fig. 3. The four wheels J, K, C, E also comprise such a train, but one of different proportions to the wheels in the pulley L. The pulleys L and N are provided with brake drums R, S, by which either can be held stationary, while the central pulley M is driven. If, for instance, the pulley L be held stationary by the band brake on the drum R, the gear wheel G will roll round on the wheel D and carry with it the wheel H in the same direction as the motion of the pulley M, thus driving the shaft A by means of the wheel B. It will be evident that the pulley N must be allowed to rotate loosely, otherwise the gear would become locked. On the other hand, if the pulley N is braked, and the pulley L is left free to rotate, the gear still being driven from the pulley M, the shaft A will be rotated by the wheel C at a different speed. By this means two speeds are produced. A third speed is obtained by running the belt on the pulleys L and M or M and N at the same time, which locks the whole of the gear and drives the shaft A at its highest speed. If means are provided for braking the pulley M, two more speeds may be obtained by driving either the pulley L or the pulley N. Therefore, by means of this mechanism, five different speeds of the shaft A are possible. If the pulley L is dispensed with, and a brake drum R' is fitted on the casing as shown, only four speeds are possible. Further, by choosing suitable proportions of the various toothed wheels in the gear, it is possible to cause one of the methods of driving to rotate the shaft A in a reverse direction.

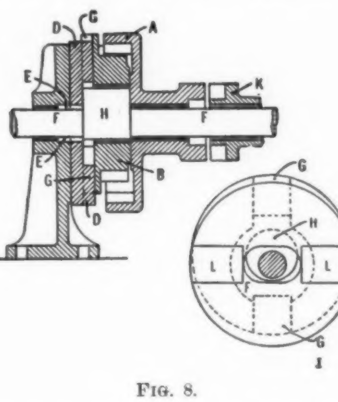


FIG. 8.

The designs for change-speed mechanisms are exceedingly numerous, many of them being very ingenious combinations, comprising bevel-wheel epicyclic trains operated by special forms of friction clutches. It is in such mechanisms that epicyclic gearing finds the greatest number of applications at the present day.

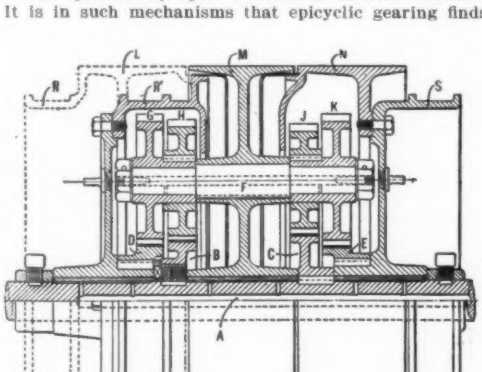


FIG. 9.

The steering handles of motor cars are also fitted with a compound epicyclic reverted train in order that the steering may be what is known as "lock steering," or irreversible; that is, the tendency of the wheels to rotate the steering handle is prevented.

During recent years most of the large structural engineering and shipbuilding firms have fitted their yards with a complete installation of compressed air for working small tools. By this means the work on large structures, such as bridges and ships, has been considerably simplified and lessened. As a result of such a universal adoption of compressed air as a motive power, the various pneumatically-operated tools have been considerably improved. As a rule, the compressed air motors used for driving these tools run at a very high speed, too high for ordinary working. Some means must therefore be adopted to reduce this speed, and this has led to the application of epicyclic gearing in connection with such compressed air motors, one of the most notable being that shown in Fig. 10, which is a section of a Boyer pneumatic drill. The compressed air motor comprises three cylinders A set at equal angles in the frame E, and pivoted on spindles D which act as distributing valves, each cylinder working on the same crank-pin B. This crank-pin B is fixed to the outer casing C of the machine, and the three cylinders A therefore revolve round it upon the admission of air under pressure by the valve F. The machine is rigged up against the work in a similar fashion to an ordinary ratchet brace, and is kept from rotating by the handles H. At the lower portion of the hollow shaft G, which is in one with the frame E, is keyed a toothed pinion L. In gear with this pinion are two wheels M, N rotating on spindles fixed to the crosshead O, these wheels being in turn in gear with an annular wheel fixed in the outer casing. By this arrangement the pinion L, being rotated by the motor cylinders A, causes the wheels M, N to rotate the crosshead O at a reduced speed. The motion of the crosshead is transmitted directly to the chuck R in which the drill or other tool is held. In this form of driving mechanism the power being applied on opposite sides of the engine shaft, instead of on one side only as in the earlier forms of pneumatic drills, the forces on the gear are perfectly balanced.

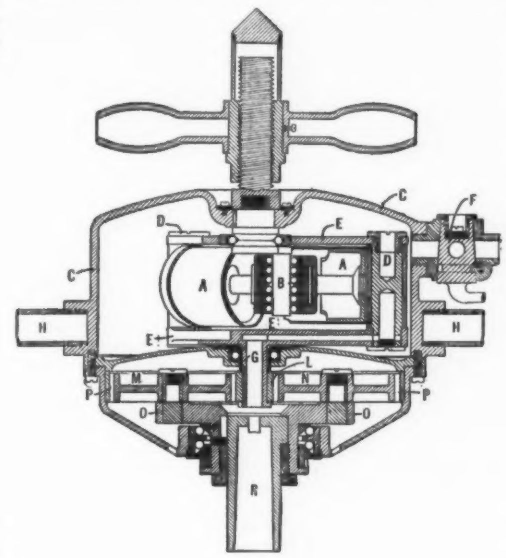


FIG. 10.

Another example of epicyclic gearing in modern machinery is illustrated in Fig. 11, which shows a portion of Brown's hydraulic steering-gear. The steering-wheel A is mounted on a shaft F, and operates the rack G by means of the pinion H. At each end of the rack is fitted a piston working in an hydraulic cylinder, not shown in the figure. The movement of these pistons communicates by hydraulic pressure pipes the motion of the steering wheel to the tiller. Since by direct driving it would not be possible to obtain sufficient pressure on the piston to operate the tiller, recourse is had to epicyclic gearing to effect this object. The gearing is fitted in the hub K of the steering-wheel and comprises two pairs of wheels B, C, D, E in gear with a wheel L on the shaft F, and a wheel M attached to the frame of the apparatus. The rotation of the shaft F for one revolution of the steering-wheel A is arranged to be a very small amount, thereby producing the requisite pressure. A pointer, for the purpose of indicating the position of the rudder, is operated from the shaft N; its rotation is effected by ordinary toothed and bevel gearing from the hub K of the steering-wheel. In a recent form of Brown's steam steering gear, the steering engine is mounted on the tiller with the controlling valve co-axial with the rudder-post. This valve is operated by means of an epicyclic train similar to that shown diagrammatically in Fig. 4. The annular wheel is mounted on the rudder and to the valve spindle is keyed the central wheel, which is rotated by means of a planet wheel, the driving-arm of which is actuated from the steering wheel on the captain's bridge.

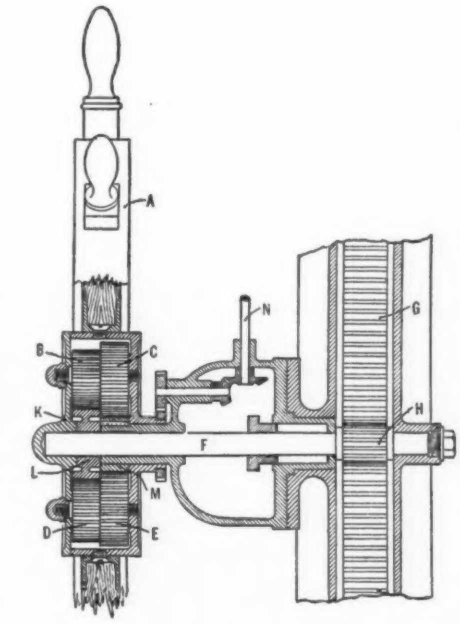


FIG. 11.

The above examples only serve to indicate the wide range of the applications of the epicyclic train. Several other uses might be mentioned which have either been introduced or greatly improved during the last few years. Such a list would include mechanism for operating and reversing the tables of printing machines, for regulating the tension of the yarn in spinning machinery, for lathes, for motor boat propelling apparatus, for hoisting machinery, for turning turrets in warships, for kinematographs and tube-expanders.

The great adaptability of this form of gearing will be obvious when the wide scope of the applications described and mentioned above is considered.

THE ELEMENTS: VERIFIED AND UNIFIED.[1]

IT is the sad duty of the retiring chairman of this section to chronicle the death of two members. One of them, James Francis Magee, B.S., University of Pennsylvania, 1887, devoted his life chiefly to commercial pursuits, in which he was most successful. He joined the association at the fifty-first meeting, being one of the youngest members. The other was H. Carrington Bolton, Columbia, 1862 (Ph.D. Göttingen, 1865), who, with the exception of four (Gibbs, Boye, Brush and Hilgard), was the senior of the section, having joined at the seventeenth meeting. I beg permission to quote from an article of his in the American Chemist, 1876, the year following his elevation to fellowship in the association, as it exemplified in telling words one of the great aims in his life, with the fruitful accomplishment of which you are familiar:

"So rapid are the strides made by science in this progressive age and so boundless is its range, that those who view its career from without find great difficulty in following its diverse and intricate pathways, while those who have secured a footing within the same road are often quite unable to keep pace with its fleet movements and would fain retire from the unequal contest. It is not surprising, then, that those actually contributing to the advancement of science, pressing eagerly upward and onward, should neglect to look back upon the labors of those who precede them and should sometimes lose sight of the obligations which science owes to forgotten generations."[2] His numerous contributions to and intimate knowledge of the history of chemistry, his gentle and generous sympathy, aided and stimulated many active in research or technical applications of chemistry. His monumental bibliographies put out by the Smithsonian Institution are masterpieces. The grief and keen regret of his loss are not confined to one nation.

On another occasion it has been the good fortune of him who has the honor of addressing you to-day to indicate that events of literary moment, governmental modifications, inventions and forward stridings in science, have apparently accommodated themselves to historical periods during the past century.[3] Striking, novel facts and fancies, gleaned in the realm of inorganic chemistry, have crested not a few of the high waves of those human tides that beat against the coasts of the untried and unknown.

The human mind knows by contrasts. For the day we have night; for the good there is evil. Where man would have a God he also had a devil; for the true there is the false; the verified and unverified. The false may be true through ignorance; the true may be false in the light of new knowledge. Or, as Hegel put it, "Sein und das nicht Sein sind das Nämliche."

Is matter continuous or discrete? argued the opposed schools of Grecian philosophy led by Leucippus, Democritus and Epicurus and dominated by Aristotle. Despite the clarity of the statements of the Roman Lucretius,[4] the atomic hypothesis received scant attention until the seventeenth century of the Christian era, when Galileo's experimental science assailed Aristotelian metaphysics and demanded verification of the premises of that philosophy which had governed all the schools of Europe for two thousand years.[5] While Gassendi, Boyle, Descartes, Newton, perhaps Boscovich, Lavoisier, Swedenborg, Richter, Fischer and Higgins had to do with our modern atomic theory, Dalton one

[1] Address of the vice-president and chairman of Section C, Chemistry, of the American Association for the Advancement of Science, St. Louis meeting, December 28, 1903.

[2] "Notes on the Early Literature of Chemistry—The Book of the Balance of Wisdom," New York Academy of Sciences, May 29, 1876.

[3] "The Rare Earth Crusade; What it Portends, Scientifically and Technically," Science, N. S., XVII., 722-781.

[4] "Nature reserving these as seeds of things
Permits in them no minish nor decay:
They can't be fewer and they can't be less."
Again, of compounds—
"Decay of some leaves others free to grow
And thus the sum of things rests unimpaired."
Book II., 79.

[5] See "The Atomic Theory," the Ylide Lecture by F. W. Clarke at Dalton Celebration, May, 1903.

hundred years ago "created a working tool of extraordinary power and usefulness" in the laws of definite and multiple proportions. As Clarke[6] remarked, "Between the atom of Lucretius and the Daltonian atom the kinship is very remote." Although the lineage is direct, the work of Berzelius, Gmelin and others; the laws of Faraday, Gay Lussac, Avagadro, Dulong, and Petit; the reformations of Laurent and Gerhardt, but particularly Cannizzaro; the systematizations of De Chancourtois, Newlands, Hinrichs, Mendelejeff and Lothar Meyer; the stereo-chemistry of Van't Hoff and LeBel have imperialized the ideas of the Manchester philosopher, so that the conceptions of the conservative atomists of to-day are quite different from those at the beginning of the closed century.[7]

These have not come about solely through the additive labors of the savants mentioned, for they have been shaped quite as much by speculative and experimental opposition exemplified by Brodie[8] and Sterry Hunt.[9]

In Graham's "Speculative Ideas Respecting the Constitution of Matter"[10] we have the conception that our supposed elements possess "one and the same ultimate or atomic molecule existing in different conditions of movement."[11] Apropos, we have the suggestion of F. W. Clarke[12] that the evolution of planets from nebulæ, according to the hypothesis of Kant and Laplace, was accompanied by an evolution of the elements themselves. Even Boyle—"the cautious and doubting Robert Boyle," as Humboldt said of him—was inclined to the belief that "all matter is compounded of one primordial substance—merely modifications of the *materia prima*."

The Daltonian ideas had scarcely reached adolescence before Prout (1815), giving heed to the figures concerned, would have all the elements compounded of hydrogen. The classical atomic mass values obtained by sympathetic Stas and the numerous investigations of those who followed him, with all the refinements human ingenuity has been able to devise, temporarily silenced such speculations, but not until Marignac had halved the unit, Dumas had quartered it, and Zängerle, as late as 1882, insisted upon the one-thousandth hydrogen atom.

The notion, like Banquo's ghost, will ever up, for if one may judge from the probability calculations of Mallet[13] and Strutt,[14] a profound truth underlies the now crude hypothesis.

Crookes,[15] from observations made during prolonged and painstaking fractionations of certain of the rare earths, supported his previously announced "provisional hypothesis" as to the genesis of the elements from a hypothetical protyle, which existed when the universe was without form and void. He designated those intermediate entities, like yttrium, gadolinium and didymium, "meta-elements,"[16] a species of compound radicals, as it were. Urstoff, fire mist, protyle, the ultragaseous form, the fourth state of matter[17] was condensed by a process analogous to cooling; in short, the elements were created. The rate of the cooling and irregular condensation produced "the atavism of the elements," and this caused the formation of the natural families of the periodic system. Marignac[18] criticising this hypothesis, states: "I have always admitted[19] the impossibility of accounting for the curious relations which are manifested between the atomic weights of the elements, except by the hypothesis of a general method of formation according to definite though unknown laws, even when these relations have the character of general and absolute laws."

Further, "I do not the less acknowledge that the effect of constant association of these elements is one of the strongest proofs that can be found of the community of their origin. Besides, it is not an isolated fact; we can find other examples such as the habitual association in minerals of tantalum, niobium, and titanium."

Sir John Herschel thought that all the atoms were alike and the elements, as we know them, "have the stamp of the manufactured article."

Hartley[20] this year says: "It is more than twenty years since the study of homology in spectra led me to the conviction that the chemical atoms are not the ultimate particles of matter, and that they have a complex constitution."

The peculiar discharge from the negative electrodes of a vacuum tube was investigated many years ago by Hittorf and Crookes, who arrived at the conclusion that it was composed of streams of charged particles. All are familiar with the very recent proposed "electrons" and "corpuscles" resulting from the beautiful physical researches of Lodge and J. J. Thomson. These appear to have caused a trembling in the belief of many in the immutability of the atom, and the complete abandonment of the atom is seriously discussed by others.

"If the electrons of all elements are exactly alike, or, in other words, if there is but one matter, just as there is but one force, and if the elements be but the various manifestations of that one matter, due to a different orbital arrangement of the electrons, it would seem that we are fast returning to the conceptions of the middle-age alchemist. The transmutation of metals involves but the modification of the arrangement of the electrons." Such efforts as Fittica's[21] should not be treated with scorn, but given careful examination and merited consideration, as Winkler[22] gave his. Science should thus ever be "a foe of raw haste, half-sister to delay."[23]

Although by chemical means, so far, we have been unable to break up the atoms, apparently electrical energy, in the form of cathode rays, for example, follows the grain of atomic structure. Some advanced thinkers look upon the atoms as disembodied charges of electricity. Ostwald has taught it. Electric charges are known only as united to matter, yet Johnstone Stoney and Larmor have speculated on the properties of such charges isolated. "Such a charge is inertia, even though attached to no matter, and the increase of inertia of a body due to electrification has been calculated by both Thomson and Oliver Heaviside, the conception accordingly being advanced that all inertia is electrical and that matter, as we know it, is built up of interlocked positive and negative electrons. If it were possible in any mass of matter to separate these electrons then matter would disappear and there would remain merely two enormous charges of electricity." We are aware of phenomena attributed to the negative electrons; we await anxiously the announcement of the positive electrons. But here the water is deep and one may not swim too well.

We do know, however, as A. A. Noyes says,[24] that "there exists in the universe some thing or things other than matter which, by association with it, give rise to the changes in properties which bodies exhibit, and give them power of producing changes in the properties of other bodies." Further (p. 15), ". . . matter is that which gives rise to the localization of the complex of properties which certain portions of space exhibit. Even though, on the one hand, it must be admitted that the existence of matter is inferred only from various energy manifestations which bodies exhibit, it must be acknowledged, on the other, that there are no manifestations of energy except those which are associated with the manifestations of it that have led to the adoption of the concept of matter; in a word, the two assumed entities, matter and energy, are indissolubly connected in our experience." Thus, as Dumas said, "Hypotheses are the crutches of science to be thrown away at the proper time."

I have dared to sketch these conceptions in a few bold outlines, for—

"We can't enumerate them all!
In every land and age have they
With honest zeal been toiling on,[25]
To turn our darkness into day."

The imposition upon your good nature practised in the foregoing craves its pardon in an effort to seek a definition for the term element. Shall we say, as does Remsen, "An element is a substance made up of atoms of the same kind"? Can we say that it is not? Venable[26] truly says: "An element is best defined by means of its properties." These conceits are not exclusive. The properties are the result of the action of physical forces and chemical affinity, whatever that may be. Certain of the novel atmospheric gases have so far responded but poorly to the latter, as predicted before their discovery by Flawitzsky, Julius Thomsen and De Boisbaudran in 1887. This necessitates, according to Piccini[27] our dividing them at once into two classes.

Pattison Muir gives a satisfactory definition.[28] "The notion of the elements that has been attained after long, continued labor is that of certain distinct kinds of matter, each of which has properties that distinguish it from every other kind of matter, no one of which has been separated into portions unlike the original substance, and which combine together to produce new kinds of matter that are called compounds." The following simpler definition has finally served as my guide: *An element is that which has not been decomposed, so far as we are aware, into anything other than itself.* In short, it is consistent.

It is well to stop occasionally and take stock. The Daltonian centenary could not but be an opportune time. Stable, certified securities are not enumerated in the list which follows. Having in mind the second chapter of the first book of Chronicles, certain so-called elements are mentioned, for yttrium begat cerium, and cerium begat lanthanum, and lanthanum begat samarium and didymium, and didymium begat neodidymium and præseodidymium, and præseodidymium begat α and β præseodidymium, "*und so weiter*."

Unpractised as a reading clerk, I shall spare you the strain of hearing this long list of elements on probation, but submit for leisure perusal printed copies which will form an appendix to the address as published in the Proceedings of the association.

From the table have been omitted urstoff, protyle (Crookes), electrons (Lodge), corpuscles (J. J. Thomson) and pantogen (Hinrichs). It appeared also unnecessary to incorporate phlogiston, nitricum (the imaginary body, thought by Berzelius united with oxygen to form nitrogen), and aræon (ponderable caloric). According to Meissner, hydrochloric acid is composed of two equivalents of oxygen, one of water, combined with aræon and the imaginary radical murium (*vide* Bolton). Often alloys have been prepared and given names like the elements, "magnalium," for example. These are omitted also. Otherwise, I have purposely included every suggestion of an element I could obtain. The summary, while doubtless deficient, may secure an historical vindication.

What shall we do with these numerous aspirants whose recognition is urged? "These elements perplex us in our researches, baffle us in our speculations and haunt us in our very dreams. They stretch like an unknown sea before us, mocking, mystifying and murmuring strange revelations and possibilities," said Crookes, referring to the rare earths. Some have been verified, many unverified; some are true, some are false. Without doubt some have been presented without sufficient stage setting, yet the good faith of many can not be questioned. In fact, from this list, as one reads, he perceives the whole gamut of scientific emotions. There he may find the tragedies of elemental pretension, the comedies, yea, the very farces.

We need not look far to ascertain explanations for certain incorrect conclusions. The extreme rarity of the minerals in which many of the tentative elements have been detected, the excessively small percentages of the new ingredients, and the extraordinary difficulties attending their separation from known and unknown substances combine to render the investigations laborious, protracted, and costly. De Boisbaudran required 2,400 kilogrammes of zinc blend for 62 grammes of gallium. Ramsay[29] has shown one part of crypton in twenty million volumes of air, while a like amount of xenon requires one hundred and seventy million. How patiently and persistently that modest Parisian couple followed Becquerel's rays!

Furthermore, when one feels that he has obtained something novel, the absolute proof is fraught with difficulties and uncertainties. We have decided to define an element by its properties. The alterations produced in the properties of the most characteristic elements by the presence of small amounts of foreign substances are evident in steel. The influence of arsenic upon the conductivity of copper is well known, and Le Bon[30] has recently shown that traces of magnesium (one part in 14,000) in mercury cause the latter to decompose water and to oxidize rapidly in the air at ordinary temperatures. Thorium with less than a trace of actinium produces an auto-photograph.

This point can not be too strongly stressed in the rare earth field. One who has wrought with thorium dioxide well knows the influence a small amount of cerium has upon its solubility. The conflicting statements in the literature as to the colors of the oxides of the complexes, neodidymium and præseodidymium, cause one to wonder if different researches have had the same hæcceity.

An appeal to the spectroscope is of course in the minds of all my hearers.

It was once supposed that each element has its characteristic spectrum which remained the same under all circumstances. Keeler[31] calls attention to modern investigations which have shown that the same element can have entirely different spectra. For example, oxygen may be caused to have five different spectra; nitrogen, two, etc. In fact, there is no indication in the appearance of the spectra that they belong to the same substance; yet through the result of the work of Rydberg, Kayser, Runge and Precht, series of groups of lines are had which satisfy mathematical formulæ.

"It was proposed by De Gramont, at the International Congress in Paris, in 1900, and agreed, that no new substance should be described as an element until its spark spectrum had been measured and shown to be different from that of every other known form of matter." As Hartley[32] remarks, "This appears to me to have been one of the most important transactions of the congress." Radium[33] was the first to be tested by this rule. Exner and Haschek obtained 1,193 sparks and 257 arc lines for Demarçay's europium. It must not be forgotten, however, that by overlapping, lines in mixtures may be masked, or appear, which are absent, in those bodies of the highest state of purity.[34] It must not be forgotten that pressure influences the spectrum, usually producing a broadening of the lines, as shown by Schuster, and that it may occur symmetrically or only toward the least refrangible red. Lest we forget, the spectroscope failed a long time to show radium and we knew it was there. It must not be for-

[6] Loc. cit.

[7] While I have examined much of the original literature, Venable's "History of the Periodic Law" has been most helpful. I have, furthermore, had the privilege of reading very carefully the manuscript of a work entitled "The Study of the Atom" (in press), by Dr. Venable.

[8] "Calculus of Chemical Operations." J. Chem. Soc., 21, 367, (1866), and his book, "Ideal Chemistry," 1880.

[9] Numerous papers summarized in "A New Basis for Chemistry." New York, 1887 and 1892 (fourth edition).

[10] Proc. Roy. Soc., 1863.

[11] Venable, "The Definition of the Element," vice-presidential address, Section C, American Association for the Advancement of Science, Columbus meeting, 1899.

[12] "Evolution and the Spectroscope," Pop. Sc. M. Jour., 1873.

[13] Phil. Trans., 171, 1003, 1881.

[14] Phil. Mag. (6), 1, 311.

[15] Chem. News, 55, 83, 1886.

[16] Address before Chemical Section of the British Association, Chem. News, 54, 117, 1885.

[17] Crookes, Royal Societies, June 10, 1880.

[18] Archives des Sciences Physiques et Naturelles, 17-5; Chemical News, 56, 39.

[19] Remarks made in 1860-5 after publication of Stas's "Researches on Atomic Weights." Archives, 9, 102, 24-376.

[20] Address before the Chemical Section, British Association, Southport meeting, September, 1903, Chem. News, 88, 154.

[21] "Black Phosphorus, or Conversion of Phosphorus into Arsenic," Chem. News, 81, 257; 82, 166.

[22] Berichte, 33, 10; Chem. News, 81, 305.

[23] Van Dyke in "The Ruling Passion."

[24] "General Principles of Physical Science," p. 13, 1902.

[25] Aikens' poem at Priestley centennial, Am. Chemist, 1875, 23.

[26] The "Definition of the Element," loc. cit.

[27] Zeit. Anorg. Chem., 19, 295, 1899.

[28] "The Alchemical Essence and the Chemical Element," London, 8vo, pp. 94, 1894.

[29] Zeit. phys. Chem., 44, 74, 1903.

[30] Compt. Rend., 131, 706, 1900.

[31] Scientific American Supplement 88, 977, 1894, and Popular Astronomy.

[32] Address before the Chemical Section of the British Association, Southport, 1903.

[33] Runge and Precht, Am. Physik, IV., 12, 407, 1903.

[34] British Association, Report, 1880, 275. Vide also Lockyer and Frankland, Proc. Roy. Soc., 27, 288, 1869.

gotten, as Krüss[25] has shown, that the "influence of temperature can not be neglected and ignored, but must be considered by every chemist who wishes to make correct spectroscopic observations." It is well known to spectroscopists that band spectra are obtained at temperatures intermediate between those required for the production of continuous spectra and line spectra.[26] The explanations of these facts do not concern us at present.

(To be continued.)

ZODIACAL LIGHT: OBSERVATIONS ON MT. BLANC

A SERIES of observations upon the zodiacal light have been made not long ago by A. Hansky. He gives the following account of the results, which present some new points:

The summit of Mt. Blanc presents very favorable conditions for observing the zodiacal light, on account of the purity and the rarefaction of the air, and the entire absence of diffused light. In my first ascension, during the nights of the 21st and 22d of September, 1904, I was able to make the following observations. Owing to the exceptional conditions I found many details regarding the zodiacal light which are scarcely visible in our latitudes. The form of the zodiacal light is a spherical triangle whose apex is situated very near the ecliptic. In space it no doubt has the form of a double-convex lens. The height of the apex of the triangle at the time of observation (3. h. 40 m. mean Paris time) was 52 deg. The length counting from the center of the sun, is 80 deg. Its width at the horizon is 25 deg. and the width in the plane of the sun's axis 30 deg. This triangle is not symmetrical with reference to the ecliptic. It is wider in the northern part, but is not so well defined here as in the southern part. The ratio of these two parts is 2 to 1. The intensity of the light increases toward the center, but the maximum is not situated on the ecliptic. It is 3 degrees distant from the latter. The apex of the triangle has a latitude of +2 degrees. We can distinguish three zones of the zodiacal light. The first (diffused light) has the form of a spherical triangle which we mentioned and it is very weak. The second (medial light) is somewhat parabolic, and the third (central light) has the form of a parabola. These portions change from one to the other by insensible degrees. The upper parts of the zodiacal light are very weak. At the distance of 55 deg. from the sun its intensity is equal to that of the Milky Way. At 40 deg. it is double and at 30 deg. it is triple the latter value. As to the color of the zodiacal light, it is very difficult to estimate on account of its low intensity. According to my observation it is white with a tendency to the green, but M. Beaudouin, the government architect, who observed this phenomenon with me upon Mt. Blanc, finds it of a yellowish hue. His drawings of the zodiacal light are in accordance with mine.

It would be of great value to continue the observation of the light, with special attention to the following details: 1. To study the form of the light and make close drawings of its position and its limits among the stars. 2. To observe its intensity in different parts, comparing it with the Milky Way. These determinations will permit us to see the variations in intensity, which may perhaps be connected with the periodicity of the sun's activity. The color of the light should also be determined. 3. To observe the specter, which shows a very weak band in the green (500 — 555). 4. Photographs should be taken of the phenomenon at regular intervals. Simultaneous observations should be made in places at a great distance from each other so as to find whether the light changes its position or form according to the place of observation. If this phenomenon is purely terrestrial, as Arrhenius supposes, the zodiacal light will not have a parallax, since in this case it follows the observer like a shadow. If, on the contrary it belongs to the sun, it will have a parallax which is quite appreciable in the upper parts which are the nearest to the earth. I am led to consider the zodiacal light as an electric phenomenon of the same kind as the solar corona and the aurora borealis. According to the recent theories, the sun throws off from its surface in all directions a series of very small particles having a negative electric charge. These particles, which are detached from the sun's surface at the places where the activity is greatest and have a diameter of 1 micron, are repelled by the pressure of the solar light with a force exceeding the attraction. They move with a speed of several thousand miles per second and electrify all the matter which they encounter. This electrified matter causes the phenomenon of the solar corona and the zodiacal light. When they arrive near the earth, the particles produce the aurora borealis and other terrestrial electric phenomena. The rays of the corona show the direction of these jets of particles which generally move in a direction perpendicular to the sun's surface. As the activity of the sun is greater in the zones situated near its equator, especially in the periods of the minima of the spots, the corona has a greater extent in the plane of the sun's equator, especially during the years of the minima. In an exceptional case the sun's corona was seen to extend in this direction as far as 12 radii of the sun. (Prof. Langley's observations during the eclipse of 1878.) We are led to believe that the corona extends still farther, but the diffused light of the heavens and that of the corona itself (which is more intense than the full moon) do not allow us to see the outer and very dim parts of the corona during the total eclipses. The zodiacal light may be considered as the extension of the corona. The electrified particles coming from the sun do not move in a straight line, but under the action of a force which seems to be magnetic, they have a tendency to approach the plane of the sun's equator. If the speed of the particles is slow, this tendency becomes strongly marked. This explains the form of the corona at the period of the minima, which is that of a double-convex lens which is considerably flattened in the plane of the sun's equator. The rays of the corona during the minima of the spots have the form of a brush discharge curved toward the equator, and their speed must be very small. As they move away from the sun, these particles lose their speed and continue to take a direction parallel to the plane of the sun's equator, while farther on they move in a straight line. In this way we may explain the form of the zodiacal light, which is lenticular, and in the places which are far removed from the sun it is plane and parallel to the plane of the sun's equator.

[25] "The Influence of Temperature upon the Spectrum: Analytical Observations and Measurements," Liebig's Annalen, 238, 57; Chem. News, 56, 51.

[26] "Spectrum Analysis," Landauer, English translation by Tingle, p. 70.

SELECTED FORMULÆ.

Bronzing—Antique Bronzes.—In order to give new bronze castings the appearance and patina of old bronze, various compositions are employed, of which the following are the principal ones:

1. Vert Antique: Vinegar, 1 liter; copper sulphate, 16 grammes; sea salt, 32 grammes; sal-ammoniac, 32 grammes; mountain green (Sanders green), 70 grammes; chrome yellow, 30 grammes; ammonia, 32 grammes.

2. Vert Antique: Vinegar, 1 liter; copper sulphate, 16 grammes; sea salt, 32 grammes; sal-ammoniac, 32 grammes; mountain green, 70 grammes; ammonia, 32 grammes.

3. Dark Vert Antique: To obtain darker vert antique, add a little plumbago to the preceding mixtures.

4. Vinegar, 1 liter; sal-ammoniac, 8 grammes; potassium bioxalate, 1 gramme.

5. Water, 120 grammes; copper sulphate solution, 80 grammes (d = 1.46); sal-ammoniac, 10 grammes; cream of tartar, 3 grammes; sea salt, 60 grammes.

6. Vert à l'eau: Vinegar, 1 liter; sal-ammoniac, 50 grammes; ammonia, 50 grammes; mountain green, 70 grammes; chrome yellow, 30 grammes.

For bronzing, immerse the object in any of the foregoing mixtures or cover it rapidly with a soft brush. The object will turn more or less green according to the length of time it is immersed or has been under the action of the fluid. The excess of the fluid is removed by means of a long-haired brush, and after that the article is allowed to dry for twenty-four hours. A second or even third coating may be applied, if necessary, in order to obtain darker shades. The bronze is finished by an energetic brushing with wax or olive oil or a mixture of both. It takes longer to produce the vert à l'eau; with Formula No. 6 a good result is obtained.

Art Bronzes.—These are bronzes of different tints showing a great variety according to the taste and fancy of the operator.

1. After imparting to an object a coating of vert antique, it is brushed to remove the verdigris, and another coat is applied with the following mixture: Vinegar, 1 liter; powdered bloodstone, 125 grammes; plumbago, 25 grammes. Finish with a waxed brush and a coat of white varnish.

2. Cover the object with a mixture of vinegar, 1 liter; powdered bloodstone, 125 grammes; plumbago, 25 grammes; sal-ammoniac, 32 grammes; ammonia, 32 grammes; sea salt, 32 grammes; finish as above.

3. Apply a coat of white varnish on the dipped article; a little plumbago and lampblack should be added to the varnish. Or after heating the object, cover it with an orange-colored varnish to resemble gold.

4. In order to produce an oak color, the following composition is used: Vinegar, 1 liter; sal-ammoniac, 30 grammes; liquid ammonia, 30 grammes; bloodstone, 125 grammes.

Smoked Bronzes.—This kind of bronzing is intended to give to new castings of bronze metal the shades of antique bronze. Green and Florentine bronzes are also smoked in order to give them a richer patina. The process of smoking is carried out in special ovens. The most common model is composed of masonry 1½ meters in height and 1 meter in depth having a grate 40 centimeters high. The oven is separated into two parts by a horizontal partition pierced with holes of a diameter of 1 centimeter and 3 centimeters apart. The objects to be smoked are placed on top of the partition by hooking them on rods or pins.

The objects are first heated by means of a charcoal fire; after that peat is burned on top of the charcoal, thereby avoiding the generation of flames. When the proper shade has been obtained, the piece is removed from the oven and allowed to cool. The greater the heat, the more thoroughly the objects will be smoked. Hay may also be employed in place of the peat.

The operation is completed by using a waxed brush or applying a coat of varnish. Polish with a piece of kid glove and English rouge or a wad charged with wax.

Varnished Bronzes.—Bronze varnishes are produced with copal varnish and Dutch varnishes and powdered bronzes. Green, black, and brown shades are prepared as explained above. Apply a coat of varnish, and before the second coat of varnish has had time to dry, the bronze powder ground in a little spirit of turpentine is put on. Let dry, and brush with a waxed brush. The shade may be greatly varied according to the mixture of powdered bronze employed.

In conclusion we would mention the aniline bronzes. Dissolve 10 grammes of fuchsine and 5 grammes of Paris violet in 100 grammes of alcohol (95 per cent). Add 5 grammes of benzoic acid and let boil; then add 32 grammes of benzoin gum (gum benjamin) and allow to boil again for ten minutes. In this manner a very fine varnish of brilliant gold color will be obtained.—Revue Chronométrique.

ENGINEERING NOTES.

Owing to the success attending the experiments that have been carried out by the French military department with a new type of heavy gun invented by Capt. Tournier of the artillery, this weapon is to be adopted for siege and coast-defense batteries. This arm is of 240 millimeters. A new field artillery gun of 155 millimeters, the invention of another French officer named Ramialho, has also undergone successful tests. Both these guns are superior to any of those that are now employed in the service.

Some high speeds have been attained on trials with the new and reconstructed warships for the German navy. The battleship "Braunschweig" during a five hours' run made an average of 18.43 knots against a contract speed of 18 knots. In an endurance trial of eleven hours the engines developed an average of 11,588 horse-power. With the engines developing 10,270 horse-power, the speed was 16.41 knots, and 17.497 knots with 12,730 horse-power. The coast-defense ship "Aegir" after her reconstruction attained during the trials a maximum speed of 15.27 knots. The armored cruiser "Friedrich Karl" in a twenty-four hours' run averaged about 18.7 knots, her engines developing an average of 17.759 horse-power in a high sea against a strong wind. The protected cruiser "Bremen" made 23.288 knots on the measured mile in deep water. In an endurance trial of ninety-three hours her engines averaged 124 revolutions. At 120.55 revolutions her speed was 20.327 knots, and at 135.88 revolutions 22.466 knots. The torpedo boats S 123 and S 125 made 28.3 knots on trial though only built for 27 knots. The latter boat is fitted with turbines.

The Pintsch light used in a large proportion of the most important passenger trains in Europe as well as the United States, is now being improved by the use of an incandescent mantle. The compressed oil gas used in this system gives a light of about 8 candle-power per foot per hour, while with the mantles used on a British train 25 to 30 candle-power is obtained from 0.6 cubic foot. According to Engineering, a Brighton & South Coast train fitted with these mantles is most brilliantly lighted, and the illumination is far better than on the best-lighted trains with ordinary Pintsch burners. The main difficulty in using incandescent mantles has been their short life, due to the jarring of the car. The tougher mantles recently introduced have an average life of two months, and have a wire cage below them which catches and retains their fragments. These pieces are still played on by the flame and give a fair light, so that the failure of a mantle does not entirely extinguish its light. If this system is as successful as reported, it ought to be introduced into the United States at once. One of the most unsatisfactory features of traveling is the poor light in the cars, which makes reading a severe strain on the eyes, and it is gratifying to learn that the engineers of the English Pintsch company have made such an important improvement.

The losses of life and property from explosions in coal mines in the past have been enormous and appalling and much study and investigation has been done to find the causes with a view to prevent or minimize such accidents. Firedamp, when mixed with air, was at first thought to be the sole source of danger, and when firedamp is present no one will deny that this may be sufficient to produce most disastrous explosions when fired, but serious explosions have occurred in mines thought to be free from explosive gases. It was only about a century ago that coal dust began to be recognized as a possible factor in colliery explosions. In 1844 Faraday and Lyell made a series of experiments at the Haswell mine, in England, after a serious explosion had occurred, and they concluded that coal dust had played an important part in the explosion. Later in the century attention again became directed to the influence of coal dust in some of the disastrous colliery explosions that took place. In England, France, and Germany elaborate investigations were instituted which added much to our knowledge of this subject. There is still some disagreement as to whether a mixture of coal dust and air alone is explosive, but it is generally conceded that even when a small percentage of firedamp is present the mixture becomes exceedingly dangerous. The all important thing to be determined in an investigation of this subject is whether a mixture of coal dust and air free from any possible mixture of firedamp or other explosive gases could, under any condition, be exploded. This fact once established, the possibility of such an explosion occurring in a non-gaseous mine must be recognized. Experiments were made in Great Britain by Galloway, Hall, Lishman, and others in artificial galleries both on a small and on a large scale, in which shots from a cannon or pistol were fired in an atmosphere heavily charged with coal dust but free from explosive gases. In some cases an ignition or explosion took place and was propagated throughout the entire length of the galleries. In other cases there was simply an elongation of the flame from the shot without ignition. The certainty of an explosion was found to depend on the fulfillment of a number of conditions, among which are the fineness, the state of dryness, and

purity of the dust; the amount of dust in suspension; the kind and quality of the powder used to produce the initial explosion; the tamping used, etc. If any one of these and perhaps other conditions was unfavorable no explosion was produced, but when every condition was favorable violent ignitions and explosions resulted.—Mines and Minerals.

SCIENCE NOTES.

Although manifest benefits have been derived from the use of X-rays, yet their use is not without some element of danger, says Dr. Holland. "The most recent case of this kind is one that has occurred in America. Dr. Weigel, of Rochester, N. Y., one of the most skillful and enthusiastic of American surgeons who used X-rays, was in England one year ago. He was then suffering very badly from chronic dermatitis of the hands. A short time ago cancer supervened, and on October 11 it was found necessary to amputate the right hand at the wrist, and to remove the first, second, and third fingers, and a portion of the metacarpus of the left hand. One may expose one's hands to the rays with impunity for years, but the risk is great, and I have no doubt that the effect of these constant exposures is, so to speak, cumulative, and that, as time goes on, the hands get more and more 'tender' to the rays. It matters not very much whether the effects produced are caused by the X-rays themselves, or some other agent; whatever it is, an active X-ray tube is a danger to the operator, and one cannot be too careful in guarding oneself against this danger. At the same time, certain articles in the daily press are calculated to do harm, as many of the general public reading them may be led to conclude that there is danger of chronic dermatitis and cancer being caused by having an X-ray examination made, or by being treated with X-rays. Some people, on this account, may be led to refuse either to be examined or treated by the rays when either the one or the other may be necessary. It may be definitely stated that no harm whatever can follow a properly conducted X-ray examination, and I think one is also justified in saying that the treatment by X-rays in skilled hands is also harmless."

The different forms of alkaline salts which are found in the region of Lake Tchad are discussed in a paper recently presented to the Académie des Sciences by M. H. Courtet. Lake Tchad may be considered as the southern limit of a vast region of central Africa extending to the north as far as Bilma (18 deg. 30 min. lat., 11 deg. long.), on the west to Agades (17 deg. lat., 6 deg. long.) and on the east to Dar Ouara (18 deg. lat., 20 deg. long.) and in which alkaline salts are abundant. The Bilma salt is well known, and according to Barth, two varieties of salt are found here, a chloride of sodium having a bitter taste and another salt of better quality which can be used by Europeans. Long saline needles were noticed by him on the edges of the extraction basins and these may be sulphate of magnesia. The same explorer states that natron is found to the northeast of Agades. M. Courtet, who formed part of the expedition to Lake Tchad, examined the lake region as to this matter and finds that the district to the east and northeast of the lake is characterized by a series of basins or lagoons which communicate to some extent with the lake at times of high water and then dry up, leaving an alkaline crust upon the soil. One of the largest of the lagoons was observed especially. Just after drying, the saline crust of several millimeters thickness which forms upon the ground is composed of a mixture of carbonate and sulphate of soda, with traces of chloride of sodium. Later on, when the water is still low, the crust is mainly formed of sulphate of sodium. At 120 miles to the east of Lake Tchad, the Redema lagoon was observed. After drying, the water leaves a crust of 5 millimeters thickness upon the ground, containing mostly chloride of sodium with carbonate of lime and a little carbonate and sulphate of sodium. The author also procured samples and data from some of the unexplored regions. The Dar Ouara, which is fed by three streams, furnishes three kinds of salts which he examined at Paris. The first is a rock salt which is found in stratified layers in the bed of the Rahat Saraf, which has water only in the rainy season. In the dry season the soil is dug to two feet depth and the salt is taken out in small blocks of 3 to 5 inches thickness. It is formed of large crystals and contains considerable sulphate of magnesia (epsomite) which becomes powdered in the air. The second is an impure rock salt in pieces of a reddish color, containing nearly 50 per cent of earthy or silicious matter and small pebbles. The third variety is the saline matter which is commonly known as natron and which is composed of the mineral variety *trona* ($3Na_2O.\ 4CO_2.\ 5H_2O$), coming from Ouadi Demi. The trona of Dar Ouara forms a veritable rock and shows a great resemblance to the variety which comes from the natron lakes of Egypt. The natives form it in flat pieces from two to three inches thick. It has a yellowish gray color and a cavernous structure. This material is made up of long monoclinic crystals having a very bright vitreous luster. The crystals are of unequal length and are sometimes an inch long. Sometimes a group of smaller crystals fills up the spaces between the large ones. The trona is used in preparing food where rock salt cannot be obtained, but the natives prefer the salt which is taken from certain plants and is a mixture of chlorides of sodium and potassium. They also use it in the fabrication of tobacco. The natives are acquainted with the purgative properties of sulphate of soda.

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